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BRIEF COMMUNICATION

EFFECT OF SOME COMMON OILSEEDS AND SPICES SERVING AS ADULT FOOD ON THE REPRODUCTIVE POTENTIAL OF *TRIBOLIUM CASTANEUM* (HBST.) (COLEOPTERA : TENEBRIONIDAE)

R. NARAYAN SINGH & S. S. KRISHNA[1]
Entomology Laboratory, Department of Zoology, University of Gorakhpur,
Gorakhpur, U. P., India 273 001

(*Received 23 December 1979*)

Whole wheat flour-reared *Tribolium castaneum* females lay significantly higher number of eggs if their adult diet, amongst the different yeast-enriched oilseeds tested, consists of groundnut or cottonseed instead of sesamum, linseed, mustard or toria. But these beetles completely fail to oviposit or even survive 20 days when they are maintained on one of the spices supplemented with yeast such as chilli, cardamom, cinnamon, aniseed, clove, black pepper or cumin-seed in place of coriander which, however, stimulated the females to deposit some eggs. Hatchability of eggs laid by females in the different diets was always 100%.

(*Key words:* **adult food efficiency: oilseeds, spices, reproductive potential,** *Tribolium castaneum*)

A few workers (URS & MOOKHERJEE, 1966; PUNJ, 1967; PAJNI & VIRK, 1978) have variously reported their data on the development of *Tribolium castaneum*—a major cosmopolitan pest of flour meal and different kinds of stored cereal products (KING & DAWSON, 1977)—on certain oilseeds and spices. However, information concerning the comparative dietary efficiency of these materials, offered as adult food, for oviposition and egg viability in this insect raised on whole wheat flour is completley wanting. This study is, therefore, aimed at filling up this lacuna in our knowledge.

Newly emerged adult individuals reared in the laboratory from egg stage on whole wheat flour supplemented with 5% yeast at 31 ± 1°C and RH 95±5% and arranged in single paired lots (1 male, 1 female) (SINGH & KRISHNA, 1979) were provided on emergence adequate amounts of coarsely-ground preparations of only one of those commercially obtained oilseeds (except taramira) or spices (save thymol) listed earlier by PAJNI & VIRK (1978) or whole wheat flour (control) to serve, after enrichment with 5% yeast, as food for the beetles during a 20-day experimental period. The diet and the insect pairs were held in glass vials (5 cm × 1.5 cm) (SINGH & KRISHNA, 1979, 1981) in which these tenebrionids were allowed to mate and lay eggs. Oviposition, though monitored daily, was accounted as total egg yield values computed for the entire 20-day experimental tenure with respect to each test food. The data obtained from these adequately replicated trials were subsequently statistically analysed (PATERSON, 1939.) The hatchability of the eggs laid by these females was also ascertained.

Table 1 summarises the results concerning the effect of different oilseeds and whole wheat flour fed by adult mated females of *T. castaneum* on the insect's oviposition. A significantly higher number of eggs were deposited by females when they ingested

[1] To whom request for reprint should be made.

TABLE 1. Number of eggs laid, during a 20 day period, by mated females of *T. castaneum* fed on different oilseeds or whole wheat flour during their adult lives (data pooled from five females).

Diet (enriched with 5% yeast)	Mean number of total eggs laid
Whole wheat flour (Control)	57.20 a
Groundnut	42.20 ab
Cottonseed	35.00 b
Sesamum	17.40 c
Linseed	15.80 c
Mustard	4.20 c
Toria	4.20 c
Mean	25.14
LSD (1%)	29.84
(5%)	22.12

Any two means followed by the same letter do not differ significantly at the 1% or 5% level by the Least Significant Difference (LSD) test.

groundnut ($P<0.01$) or cottonseed ($P<0.01$ or <0.05) supplemented with yeast instead of other oilseeds. No statistical difference was, however, observed in the oviposition between beetles maintained on groundnut and whole wheat flour both fortified with yeast ($P>0.05$) the latter diet, nonetheless, stimulating a markedly greater egg laying in comparison to cottonseed ($P<0.05$) or remaining oilseeds ($P<0.01$). But, curiously enough, egg output by mated animals that ate yeast-added sesamum in which no adult emergence occurred (PAJNI & VIRK, 1978), although not significantly different from similarly enriched linseed, mustard or toria ($P>0.05$), was about 50% of that recorded from females whose food was cottonseed plus yeast. There was 100% viability of eggs laid by females in all these diets.

Amongst the various yeast-supplemented spices tested only coriander which completely failed to support larval development into adults (PAJNI & VIRK, 1978) enabled these beetles to be somewhat productive—the mean number of eggs (all fertile) laid per female being 10.8. All the remaining diets in this category, including those which when provided as larval food were variably effectual in producing adults (PANJI & VIRK, 1978), proved incompetent even to sustain longevity of these beetles till the close of the 20-day experimental period.

Acknowledgements:—This study was supported by funds from the University Grants Commission, New Delhi.

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BRIEF COMMUNICATION

EVALUATION OF CERTAIN SYNTHETIC CHEMICALS AGAINST BETELVINE SCALE, *LEPIDOSAPHES CORNUTUS* (RAMAKRISHNA)

N. CHANDRAMOHAN, M. S. VENUGOPAL, B. HABEEBULLAH & M. BALASUBRAMANIAN
Department of Agricultural Entomology, Tamil Nadu Agricultural University,
Coimbatore, India 641 003

(*Received 10 September 1979*)

Field Experiment was conducted on the control of betelvine scale insect, *Lepidosaphes cornutus* with eight foliar insecticides. Application of chlorpyrifos 0.04% caused higher percentage of mortality in the initial period. The residue level at the time of harvest was at below tolerance level for chlorpyrifos.

(*Key words:* **synthetic chemicals, betelvine scale,** *Lepidosphes cornutus*)

The armored scale, *Lepidosaphes corntus* is a severe pest of betelvine in different parts of Tamil Nadu. In the present study some of the newer insecticides were tested against this and residue was also investigated.

Ten months old betelvine garden at Thirumalayampalayam village near Coimbatore was sprayed with various insecticides (Table 1) each in 3 plots of 100 wines using knapsack sprayer. Spraying was done @ 1000 litre/acre. The control plot was sprayed with water alone. Mortality of the scales on leaf samples collected from top, middle and bottom portions of the vine on 5 and 11 days after spraying was recorded. The coccids were removed with a fine needle and observed under microscope for counting dead and live ones. Samples collected 1 hour and 1 month after spraying (at the time of harvest) were used for estimating the residues. Residue levels were determined by the biossay method of SUN *et al* (1965 and chemical assay methods of ANON (1968 and 1975) MAC DOUGALL *et al.* (1964), MAITLER *et. al.* (1963) and WEISENBERG *et. al.* (1968) for the various chemicals.

Among the various chemicals chlorpyrifos inflicted highest mortality of 75.38 per cent 5 days after spraying. Eleven days after spraying also chlorpyrifos caused highest mortality but it was on par with fenitrothion, quinalphos and malathion.

The residue 1 hour after spraying ranged from 3.81 to 0.58 ppm by bioassay and 10.16 to 0.92 ppm by chemical assay. At the time of harvest the residue of all the chemicals came below tolerance level.

From the study it may be concluded that the chemicals chlorpyrifos, fenitrothion, quinalphos and malathion are effective in controlling the pest. The residue levels of all insecticides were within safe limits one month after spraying.

TABLE 1. Effect of foliar sprays of different insecticdes on betelvine scale insect, *Lepidosaphes cornutus* and the insecticide residues on harvested leaves.

Insecticides used	Concentration	Mortality of scale insect		Residue Initial deposit in ppm		Residue at harvest		EPA tolerance in ppm
		5 days after spraying	11 days after spraying	Bioassay	Chemical assay	Bioassay	Chemical assay	
Lebaycid (Fenthion)	0.1%	48.33 (36.41)	52.88 (46.78)	3.81	10.16	0.21	0.12	0.75
Chlorpyrifos (Durshan)	0.04%	75.38 (60.32)	81.40 (65.15)	..	1.99	..	0.36	2.0
Malathion	0.05%	54.06 (39.22)	71.70 (58.17)	3.64	N D	N D	N D	3.0
Quinalphos (Ekalux)	0.025%	62.94 (43.62)	78.49 (62.48)	0.58	0.92	N D	0.46	2.0
Dimethoate (Rogor)	0.03%	49.19 (37.60)	34.76 (35.93)	2.89	7.10	N D	0.71	2.0
Fenitrothion (Sumithion)	0.1%	67.00 (47.03)	82.52 (65.52)	1.45	5.15	N D	0.20	0.50
Phosolone (Zolone)	0.07%	24.76 (24.47)	13.17 (20.30)	1.91	2.0	N D	N D	0.2
Endosulfan (Thiodan)	0.07%	21.17 (25.17)	27.20 (30.77)	0.73	4.4	2.7	N D	2.0
Control		0.1 (1.81)	0.1 (1.81)					

(Figures in parentheses are transformed value)

CD (P=0.05)		8.69	12.76

N D = Not Detectable

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BRIEF COMMUNICATION

BIOLOGICAL STUDIES ON *ASPIDOMORPHA FURCATA* THUNB. (CHRYSOMELIDAE : CASSIDINAE : COLEOETERA)

A. VISALAKSHI, K. SANTHAKUMARI, GEORGE KOSHY & M. R. G. K. NAIR
College of Agriculture, Vellayani, India 695 522

(*Received 10 November 1979*)

Aspidomorpha furcata THUMB. **(Chrysomelidae: Cassidinae : Coleoptera) was recorded for the first time infesting wood rose and sweet potato. Studies undertaken on its biology showed that the insect completed its life cycle in about 3 weeks. Adults and grubs fed on the leaves showed preference to sweet potato leaves.**

(*Key words : Aspidomorpha furcata*, **wood rose, sweet potato, life cycle, feeding preference)**

Wood rose (*Ipomoea*: *tuberosa* Convolvulaceae) a garden plant was found severely infested by the tortoise beetle *Aspidomorpha furcata* at Trivandrum. It was also seen feeding occasionally on sweet potato (*Ipomoea batata*) an important tuber crop of Kerala. Since the possibility of this beetle becoming an important pest of sweet potato cannot be ruled out, detailed studies on the biology of the insect were undertaken. Apart from the description of the insect and record of its occurrence in Ceylon, Sikkim, Burma, Madras, Kerala, Bombay and Calcutta by MAULIK (1919), no other information is available on it.

Rearing of the insect for these studies was carried out in glass troughs (15 cm × 10 cm × 25 cm) providing it with the host plant by keeping small branches with their cut tips immersed in water in specimen tubes. The adults were put on these cuttings for egg laying and the grubs for observations on their growth features. Biological studies were done both on sweet potato and wood rose.

Oviposition:

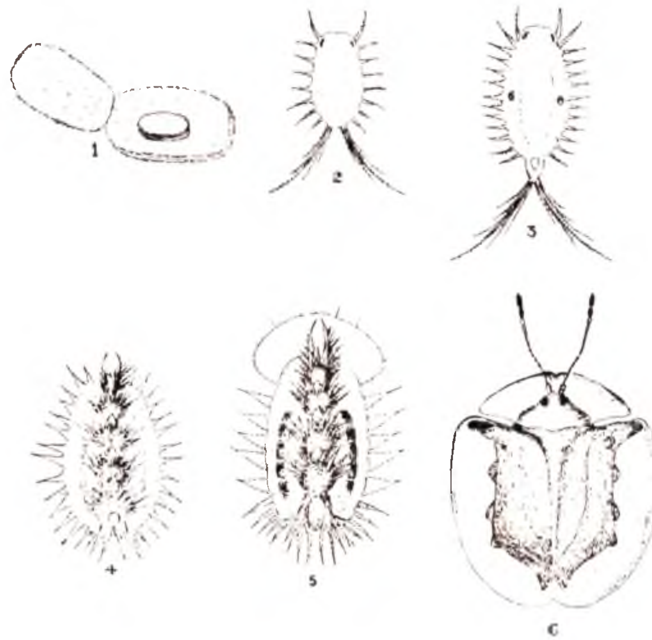
Mating takes place 7 to 9 days after emergence as adults. Gestation period is from 6 to 8 days. Eggs are laid singly or in clusters on the undersurface of leaves. The first batch of eggs are few in number being 2 to 4. The female continues to lay eggs for a period of 70 to 80 days, laying eggs daily, the total number of eggs laid being on an average 154.2.

Egg:

The egg is laid in small rectangular trays or cases made of a white papery substance (Fig. 1). One egg is laid in each egg tray and 1 to 3 such trays may be laid together arranged one above the other. The topmost tray will be closed above with a thin cover of the same material. About 43 to 50% of the eggs are laid in 2 layers, 37 to 50% in single layer and very rarely in 3 layers. The egg is ovoid in shape measuring 0.75 mm in length and 0.25 mm in width and the egg case measures 1.25 mm in length and 1 mm in width. The egg hatches out in 3–4 days.

Larva (Figs. 2 to 4)

The first instar grub (Fig. 2) is milky white in colour with 2 anal processes. It is 1 mm in length and 0.75 mm in width. It is active and feeds by nibbling on the green



matter from under-surface of leaves. It moults in 2 days and the moulted skin remains attached to the anal process (Fig. 3). The larvae are greenish white in colour. The 2nd, 3rd, 4th and 5th instars measure 2.0, 3.0, 4.0 and 5.0 mm in length and 1.0, 1.5, 2.0 and 3 mm in width respectively. The durations of the different instars are 2,2,2 and 2–3 days respectively. The exuvia of the successive moultings remain attached to the tail spines and are held dorsally on the body.

Pupa (Fig. 5)

Before the final larval moult, there is a distinct pre-pupal period when the larva stops feeding and moves about on the leaf surface. This lasts for 3 days.

The pupa is green in colour measuring 6.0 mm in length and 4.0 mm in width. The moulted skins are held dorsally on the pupa also. The adult comes out after a pupal period of 4 days.

Adult (Fig. 6)

At the time of emergence, the adult is white in colour becoming deep brown within 2–3 hours. After 7 to 9 days the beetles become shiny golden in colour. Mating starts only after the golden colour has been developed and takes place usually during day time and lasts for 20–30 minutes. The adult female measures 6 mm in length and 5 mm in width. The males are slightly smaller in size than the females.

Feeding habits

Adults feed from the under-side of the leaves. They are swift flying when disturbed. They are voraceous feeders cutting holes on the leaves. The grubs also damage the leaves by scraping the green matter from under-surface of the leaves. The whole plant is defoliated when the infestation is severe leading ultimately to the drying up of the vines.

In the laboratory when leaves of sweet potato and wood rose were supplied to the adults and grubs, there was a definite preference shown to sweet potato leaves by both adults and grubs. However, there was no change in the biological and biometric features of the different instars or the adults when reared on the two hosts; the longevity of adults also was not affected.

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A LYCAENID *RAPALA MANEA* HEWITSON AS A NEW PEST OF MANGO IN KERALA

J. JOHNSON, P. LETHIKA, A. VISALAKSHI & T. NALINAKUMARI
College of Agriculture, Vellayani, India 695 522

(*Received 23 November 1979*)

Rapala manea **HEWITSON (Lycaenidae: Lepidoptera) is recorded as a new pest of mango *Mangifera indica*. Egg, larval and pupal periods last for 2, 13 and 5.5 days respectively. Adult lays eggs in the inflorescence. The caterpillars are seen damaging both the opened and unopened flowers.**

(*Key words:* **Lycaenid, *Rapala manea*, inflorescence pest, mango)**

Mango (*Mangifera indica*) an important fruit crop in Kerala is seen severely infested by caterpillars of *Rapala manea* HEWITSON (Lycaenidae: Lepidoptera) in the Agricultural College Farm, Vellayani, during 1977–1979. The caterpillars are found feeding on the inflorescence. A related species *Rapala melampus* has been reported as feeding on the mango leaves and another *Rapala varuna* on guava in India (NAIR, 1974). The studies made on the biology of the insect is presented in this paper.

The adults are confined in glass troughs (15 cm × 20 cm × 25 cm) containing inflorescence of mango. The eggs are removed to small specimen tubes with a piece of inflorescence head and the different larval moultings are observed.

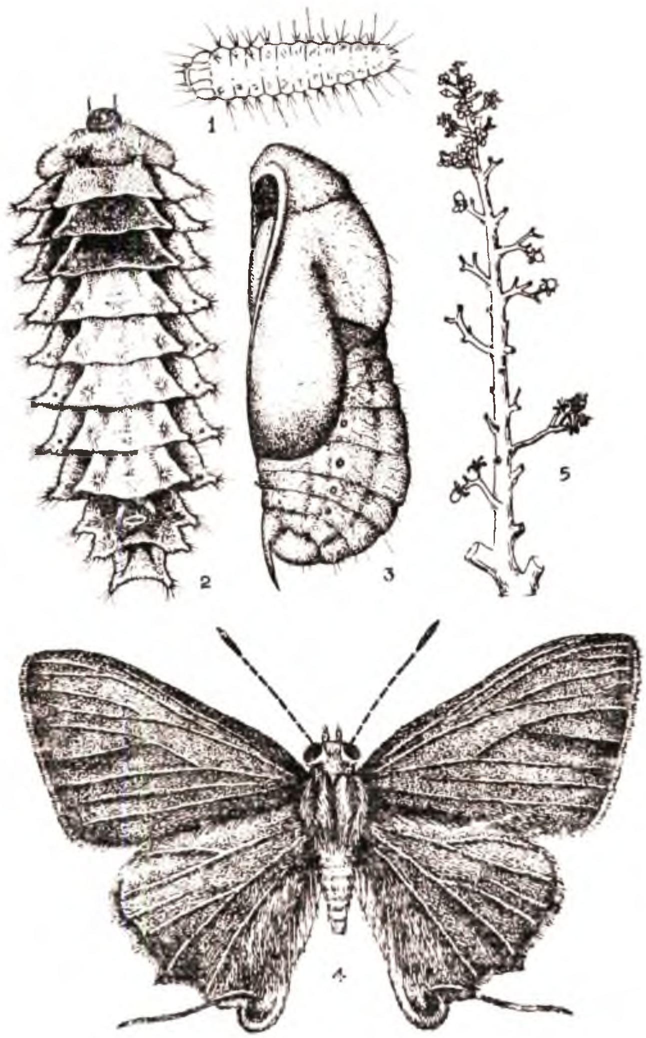
Biology

Egg: The egg is spherical and sculptured; glistening white when first laid, later turning light green. The egg measures 0.52 mm in diameter. In 2 day's time, the 1st instar larva comes out biting a circular hole on the surface of the egg.

Caterpillar: The first instar caterpillar (Fig. 1) is ash coloured measuring 1.3 mm in length. On the third day after hatching the first instar caterpillar moults. The second instar caterpillar is light brown and 3 mm long. It lasts for 3 days. The 3rd instar larva grows to a length of 6 mm and reaches the final instar within a period of 3 days. The full grown caterpillar (Fig. 2) is slug like and measures 12–13 mm; the head is hidden by the first thoracic shield, which is visible only while moving. It moults and reaches the pupal stage in 4 days, by fixing the posterior end to the substratum.

Pupa: Pupa (Fig. 3) is slightly ovoid, dirty brown, anterior region broad, posterior region narrow with a slight constriction in the middle. It is covered by minute bristles throughout the body, more bristles being in the anterior and posterior ends. Pupal period lasts for 5–6 days.

Adult: Adult (Fig. 4) is dark brown in colour, the under surface is more faded with dark centered eye spots in the hindwing near the delicate tail like prolongation. The antennae are ringed with white and a rim of scales are seen surrounding each eye. Measures 28–30 mm across the wings and 14–15 mm in body length. Male is more dark in colour. The adult flies about during day time and lays eggs on the newly formed inflorescence.



Figs. 1 to 4: Life stages of *R. manea*. 1. 1st instar caterpillar, 2. Full grown caterpillar. 3. Pupa. 4. Adult. 5. Mango inflorescence showing damage by caterpillar.

Nature of damage (Fig. 6)

The caterpillars are seen feeding on the flowers, both opened and unopened. The rachis are left behind without feeding. The newly set fruits are not seen eaten up by the caterpillars. Feeding takes place both day and night, but mostly during night.

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ON THE IMPROVEMENT OF FEMALE PRODUCTION IN *BRACON BREVICORNIS* WESMAEL

KUNJAMMA P. MATHEW, C. C. ABRAHAM, A. VISALAKSHI & M. R. G. K. NAIR
College of Agriculture, Vellayani, India 695 522

(*Received 7 December 1979*)

The over production of males in *Bracon brevicornis* WESMAEL (Braconidae: Hymenoptera) an ectoparasite of the coconut caterpillar *Nephantis serinopa* can be remedied effectively by providing 2 to 6 male parasites with each female parasite at the time of parasitisation of host larvae.

(*Key words: Bracon brevicornis*, **sex ratio**)

Bracon brevicornis WESMAEL (Braconidae: Hymenoptera) an external parasite of the coconut cater-pillar *Nephantis serinopa* MEYR. is used for its biological control. When the parasite is mass bred in laboratories, very often the progenies are preponderantly males. This affects adversely mass rearing of the parsite and the release of such populations is ineffective in controlling the pest. The present studies were hence undertaken to study the possibility of improving the female production of the parsite by varying the sex ratios of parents used for parasitising host larvae: results of these studies are presented below:

The parasite was reared on 4th instar larvae of *Corcyra cephalonica* (Pyralidae: Lepidoptera) which were bred on crushed rice. Ten larvae were taken in specimen tubes 7.5 $\times$ 2.5 cm and the parasites of different sex ratios (see Table 1) released into them for parasitisation. The parasites used for this purpose were dissected out of their pupal cocoons with needles when about to emerge and separated into males and females. This ensured that they were unmated. The parasites were fed with diluted honey for 48 hours and continued to be kept with the larvae till they died.

Results were assessed in terms of number of parasites emerged and their sex ratios.

Data presented in Table 1 will show that the number of total progeny per female was greatest (52.6 and 52.2) when the number of males used with single females was 6 and 1. Comparably high number of progeny was seen with males numbering 2 and 7 (37.4 and 37.0 respectively). All the other combinations produced significantly less numbers of parasites (24.2 to 27.8 per female). Six and three males per female combinations produced the higher numbers of 17.9 and 14.8 female progeny per mother. These were followed by combinations using 2,4 and 5 males producing 10.6, 10.2 and 9.0 females respectively which among themselves were on par. The other combinations gave significantly less number of females.

The female to male ratio was the most favourable (1.73) when the number of males used per female was 3 followed by 6 males which gave a ratio of 0.69; 5 males giving a ratio of 0.57 and 2 males with a ratio of 0.495. All other combinations gave less favourable sex ratios. When a single female was mated with a single male the number of progeny was very high (52.2) but the per-

TABLE I. Number and sex ratio of progeny of *B. brevicornis* when varying numbers of males were used with single female (Average of six replications).

Number of males used per female	Number of total adults per female	Number of female progeny per female	Female/male ratio of progeny.
1	52.2	2.4	0.0452
2	37.4	10.6	0.495
3	24.2	14.8	1.73
4	27.2	10.2	0.387
5	27.8	9.0	0.57
6	52.6	17.0	0.69
7	37.0	5.4	0.17
8	26.0	4.4	0.16
9	26.8	4.8	0.20
10	27.0	3.4	0.11
CD	20.46	3.61	0.5334

centage of females was very low (4.5%) with a sex ratio as low as 0.045. Reduction in the proportion of females was observed also when the number of males per female was increased beyond six.

It could thus be concluded that using 2 to 6 males with each female for parasitisation ensured the maximum production of female progeny in *Bracon brevicornis*.

Increasing the number of females with single males did not improve the perentage of female production.

It has been reported that parthenogensis in *B. brevicornis* was arrhenotokous and unmated females produced only males which were normal and fertile. This was attributed to lack of copulation and due to lack of sufficient host larvae as food for the developing larvae (NARENDRAN *et. al.*, Personal Communication). Rresults of the present work confirm that the over production of males may be due to lack of mating.

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BRIEF COMMUNICATION

PATHOGENICITY OF THE ENTOMOGENOUS FUNGUS *PAECILOMYCES FARINOSUS* (DICKSON EX FRIES) TO SEVERAL INSECT PESTS

SUMA KURUVILLA & ABRAHAM JACOB
Department of Entomology, College of Agriculture, Vellayani, India 695 522

(*Received 25 December 1979*)

Paecilomyces farinosus **was found to be infective to larvae of** ***Sylepta derogata, Antoba olivacea, Diacrisia obliqua, Margaronia indica, Plusia peponis, Hymenia recurvalis, Psara basalis*** **and** ***Nephantis serinopa*** **and adult of** ***Dysdercus cingulatus, Nilparavata lugens*** **and** ***Pentalonia nigronervosa.***

(*Key words:* **entomogenous fungus,** *Paecilomyces farinosus*)

ASARI *et. al.* (1977) recorded *Paecilomyces farinosus* (DICKSON EX FRIES) as a pathogen infecting larvae of *Orthaga exvinacea* in Kerala. Studies were undertaken to ascertain the pathogenicity of this fungus to few other crop pests and the results are reported in the present paper.

The fungus culture isolated from *O. exvinacea* and maintained on Czapeck's medium was used for these studies. Bugs and beetles tested were released on their host plant enclosed in hurricane chimneys and sprayed with a concentrated suspension of spores collected from 6 day-old cultures. In the case of lepidopterous insects middle aged caterpillars were allowed to crawl for one hour over heavily sporulated 6 day old cultures and then released on their host plants enclosed in chimneys. Proper humidity was ensured inside the chimneys. Mortality counts were made daily till all were dead or pupated and the pathogenicity was confirmed by reisolation of the fungus from the dead specimens. Fifteen to twenty insects were used in each test. A similar set of insects sprayed with pure distilled water or allowed to crawl for 1 hour over pure media were employed as control in each case.

Results presented in Table 1 show that larvae of *S. derogata, A. olivacea, D. obliqua M. indica, P. peponis, H. recurvalis, P. basalis* and *N. serinopa* and adults of *D. cingulatus* and *N. lugens* were susceptible to the pathogen causing over 90 per cent mortality. In the case of *P. nigronervosa* only 50 per cent mortality was observed. The fungus was not infective to adults of *A. foveicollis, A. lewsi, A. cincta, M. pustulata* and larvae of *C. medinalis, S. litura* and *P. ricini.*

Paecilomyces farinosus has earlier been recorded on potato beetle *Leptinotarsa decemlineata* (BAJAN & KMITOWA, 1969; RAMISCH, 1976), white fly *Bemisia tabaci* (NENE, 1973), pupae of *Heliothis armigera* (ALMA, 1975) and larvae of *Cydia pomonella* (LAPPA & GORAL, 1975). These observations suggest that the pathogen has a wide host range which enhances its value as a microbial control agent.

TABLE 1. Infectivity of *P. farinosus* to different crop pests.

Test Insect	Stage of insects treated	Percent mortality due to the fungus	Cross infectivity +ve/–ve
1. *Sylepta derogata*	larvae	100	+
2. *Diacrisia obliqua*	,,	100	+
3. *Margaronia indica*	,,	100	+
4. *Antoba olivacea*	,,	100	+
5. *Plusia peponis*	,,	100	+
6. *Nephantis serinopa*	,,	100	+
7. *Psara basalis*	,,	95	+
8. *Hymenia recurvalis*	,,	90	+
9. *Dysdercus cingulatus*	adults	100	+
10. *Nilaparvata lugens*	,,	100	+
11. *Pentalonia nigronervosa*	,,	50	+
12. *Aulacophora foveicollis*	,,	nil	—
13. *A. lewsi*	,,	,,	—
14. *A. cincta*	,,	,,	—
15. *Mylabris pustulata*	,,	,,	—
16. *Cnaphalocrocis medinalis*	larvae	,,	—
17. *Spodoptera litura*	,,	,,	—
18. *Pericallia ricini*	,,	,,	—

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BRIEF COMMUNICATION

RESPONSES OF *OXYRHACHIS TARANDUS* FABR. TO DIFFERENT CONCENTRATION OF SUGARS AND EGG ALBUMIN

J. R. GANDHI
Zoology Department, University of Delhi, Delhi, India 110 001

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Sugars and proteins stimulate feeding in aphids and leafhoppers. Observations on the feeding responses of a membracid *Oxyrhachis tarandus* FABR. to different concentrations of sugars and egg-albumin are presented in this paper.

The adults of *Oxyrhachis tarandus* were collected from *Prosopis julliflora* plant and kept on cotton swab soaked with water for 24 hours. Their proboscis response to different solutions was measured by the method adopted by GANDHI & SAXENA (1973) and SAXENA *et. al.*, (1974). Ten adults were offered cotton swabs soaked with sugars or egg albumin and water in a petridish (50 mm dia × 17 mm ht). These swabs were placed about 30 mm apart. The insects were observed for 30 minutes. The percentage of the insects which extended the proboscis and probed the solutions represented their proboscis response. All the experiments were carried out at the temperature 28°C–30°C and relative humidity 40–60%. The results were statistically analysed.

The results (Table 1) indicate that the proboscis response. of *Oxyrhachis* to the following chemicals were found to be statistically identical: glucose of 0.2 M, 0.1 M, 0.05M and 0.01 M concentrations, sucrose of 0.2 M, 0.05 M, 0.01 M concentrations, fructose of 0.1M, 10^{-3}M, 10^{-5}M, 10^{-6}M and 10^{-7}M concentrations and egg albumen of 10^{-2}% and 10^{-4}% concentrations. The insects preferred sugars and egg albumin to water for feeding.

Duration of feeding on 0.1 M Sucrose solution and water for one hour by single adult in different humidities was measured by the method adopted by GANDHI & SAXENA (1973). In 30% rh adults showed 32.0 ± 3.7 min feeding on 0.1 M sucrose solution. There was no feeding on water. In 90% rh, these showed 14.5 ± 3.1 min feeding on 0.1 M Sucrose solution and 2.5 ± 1.43 min on water. In both the humidities, the adults fed on sugars for longer duration than on water.

The above responses are similar to that of aphids and leafhoppers. *Myzus persicae* showed much greater probing/feeding response to sucrose solutions (10%–20%) than to plain water (MITTLER & DADD 1963, 1964, 1965). Protein albumin has been observed to stimulate feeding in leafhoppers (NUORTEVA, 1952).

The above sugars and protein egg albumin are present in *Prosopis julliflora* on which *Oxyrhachis* insects are found (GANDHI, 1979). These chemicals are phagostimulants for this insect and play a part in the establishment of insects on a plant.

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TABLE 1. Proboscis response for feeding of water-satiated adults of *Oxyrhachis tarandus* FABR. to different concentration of sugars and egg-albumin.

Solutions offered		Percentage of individual showing proboscis response for feeding to each solution.	
A	*B*	*A*	*B*
Sucrose 0.1 M	Sucrose Crystals	48.0±2.0	0.0
0.2M	Water	66.0±6.7	8.0±5.8
0.1 M	,,	50.0±9.10	2.5±2.5
0.05 M	,,	68.0±5.8	16.0±5.1
0.01 M	,,	64.0±8.7	18.0±5.8
Glucose 0.2 M	,,	66.0±10.7	10.0±1.0
0.1 M	,,	72.0±8.60	10.0±4.4
0.05 M	,,	70.0±7.0	14.0±5.1
0.01 M	,,	68.0±5.8	18.0±2.0
Fructose 0.1 M	,,	54.0±5.09	8.0±2.0
10^{-3}M	,,	64.0±9.2	8.0±2.0
10^{-4}M	,,	46.0±6.0	8.0±2.0
10^{-5}M	,,	60.0±7.0	8.0±4.9
0^{-6}M	,,	58.0±4.9	12.0±5.8
10^{-7}M	,,	54.0±5.1	10.0±5.5
10^{-8} M	,,	48.0±3.7	0.0
10^{-9} M	,,	37.5±7.5	10.0±4.1
egg albumin 10^{-3}%	,,	66.0±9.8	8.0±3.7
10^{-4}%	,,	54.0±8.7	14.0±4.0
10^{-5}%	,,	28.0±3.7	0.0
10^{-6}%	,,	26.0±4.0	2.0±2.0
10^{-7}%	,,	6.0±2.4	4.0±2.4
LS D at P=0.05		18.74	

Cotton swabs soaked with different solutions of sugars or egg albumin and water were offered to the insects.

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CONTACT TOXICITY OF ELEVEN INSECTICIDES TO SUGARCANE TOPSHOOT BORER *TRYPORYZA NIVELLA* (FABR.) (LEPIDOPTERA, PYRALIDAE)

G. C. PANDEY & R. A. AGARWAL
Department of Zoology, University of Gorakhpur
Gorakhpur, India 273 001

(*Received* 29 *December* 1979)

The toxicity of eleven insecticides to IIIrd and IVth instar larvae of the sugarcane topshoot borer, *Tryporyza nivella* (body weight 158.45 ± 12.04 mg) was determined by topical application. Zectran (LD_{50} 0.20 μg/Larva) which was 3 times more toxic than the malathion standard was the most effective insecticide tested; Phorate, Furadon, Diazinon and Formothion were 2.5, 2.5, 2.4 and 1.15 times respectively more toxic than malathion while Trichlorfon, Aldicarb, Thiometon, Disyston and Carbaryl were respectively 0.96, 0.96, 0.75, 0.57 and 0.54 times as toxic as the standard.

(*Key words: Tryporyza nivella*, **insecticides, toxicity, dosage, mortality**)

INTRODUCTION

The larvae of sugarcane topshoot borer *Tryporyza nivella* (FABR.) are a source of serious damage to sugarcane in India causing 'dead hearts' resulting in reduced yield and reduced value of the crops (KALRA & CHAUDHARY, 1964). Even though a number of chemicals for the control of this pest under field conditions (AVASTHY, 1967; YUNUS & HUSSAIN, 1973; SANDHU *et al.*, 1974; SANDHU & DUHRA, 1977) have been recommended, a satisfactory control is still not available. Perhaps toxicity studies under laboratory conditions may provide a clue to it and, therefore, the relative toxicity of 11 insecticides following topical application to mixed groups of third and fourth instar larvae has been undertaken.

MATERIALS AND METHODS

Bored shoots of sugarcane were collected from insecticide-free plots at the sugarcane research station, Gorakhpur, U.P. between the months of September and November and from there the larvae were taken out. Larvae each weighing 158.45 ± 12.04 mg in a mixed group of third and fourth instar were used for the toxicity studies.

The technical grades of insecticides: Zectran (4 dimethyl amino-3, 5 xylenyl N methylcarbamate), Phorate (O, O-diethyl S-2- (ethyl thio) methyl phosphorodithioate), Furadon (2, 2-dimethyl benzofuran 7 yl N methyl carbamate), Diazinon (O, O-diethyl O 2-isopropyl 4 methylpyrimidyl 6 phosphorothionate), Formothion (O, O dimethyl S-(N methyl N formoyl carbamoyl methyl) dithiophosphate), Malathion (O, O dimethyl S-(1, 2-dicarboxyethyl) phosphoro dithioate), Trichlorfon (O, O dimethyl (1 hydroxy 2, 2, 2 trichloroethyl) phosphonate), Aldicarb (2 methyl 2- (methylthio) propionaldehyde O (methylcarbamoyl) oxime), Thiometon (O, O dimethyl S 2 (ehtyl thio) ethyl phosphorodithioate), Disyston (O, O diethyl S 2- (ethyl thio) ethyl phosphorodithioate), Carbaryl (1 naphthyl N methyl carbamate) were made into solutions of desired strength with acetone. With the help of a microsyringe 5μl of each of the pesticide solutions were applied on the dorsal thoracic region of the larvae. A group of 10 larvae was treated with one concentration and there were five concentrations of each insecticide which were replicated at least 4 times. To a control group 5μl of pure acetone was also similarly applied. The treated larvae were placed in petridishes (10 cm diameter) lined with water saturated filter paper, chopped sugar cane pieces and kept in dark at 27°C for 24 hr following which mortality was recorded. Larvae that were unresponsive when

prodded with a blunt probe were taken as dead. Data were analyzed by probit log method and chi-square tests (SWAROOP, 1966). LD_{50} values have been expressed as μg ai larva. Toxicity indices (SUN, 1950) were calculated by using malathion as standard, as this insecticide has been recommended for use on *T. nivella* in India (AVASTHI & SINGH, 1973.

RESULTS AND DISCUSSION

LD_{50} values and other data on the 11 insecticides have been shown in Table 1. It can be seen that Zectran was the most effective insecticide followed by Phorate, Furadon, Diazinon, Formothion, Malathion, Trichlorfon, Aldicarb, Thiometon, Disyston and Carbaryl. Out of the 11 insecticides tested against the larvae of *T. nivella*, Zectran, Phorate, Furadon, Diazinon and Formothion were 3.0, 2.5, 2.5, 2.4, and 1.15 times respectively, more toxic than malathion while Trichlorfon, Aldicarb, Thiometon, Disyston and Carbaryl were less toxic than the standard (Table 1). It can be seen from Table 1 that barring Diazinon the slope of the other 10 insecticides was moderately steep ranging from 6.42 for Formothion to 11.72 for Carbaryl. LD_{50} values of all the pesticides ranged within the 95% confidence limit which was fairly narrow. Chi-squre tests did not indicate any heterogeneity in the data ($p > 0.05$).

These data clearly demonstrate that the third and fourth instar larvae of *T. nivella* were susceptible to topical application of all the 11 insecticides tested. Also, it is obvious from the moderately steep slope value for the toxicity of these insecticides (Table 1), that the larval population was fairly homogenous with respect to the insecticides tested. This is further supported by the narrow range of 95% confidence limit

TABLE 1. Toxicity of various insecticides against IIIrd and IVth instar *Tryporyza nivella* (Fabr.) Larvae*.

Insecticide (Dose tested) μg larva	LD_{50} ai. μg/larva	95% confidence limit lower	95% confidence limit upper	Slope (Log_{10})	Toxicity index
Zectran (0.06, 0.12, 0.36, 0.6, 1.2)	0.20	0.10	0.37	7.75	300
Phorate (0.04, 0.08, 0.24, 0.4, 0.8)	0.24	0.12	0.45	7.82	250
Furadon (0.037, 0.075, 0.22, 0.37, 0.75)	0.24	0.12	0.47	9.02	250
Diazinon (0.03, 0.06, 0.18, 0.3, 0.6)	0.55	0.15	0.41	5.00	240
Formothion (0.1, 0.2, 0.6, 1.0, 2.0)	0.52	0.29	0.92	6.42	115
Malathion (0.075, 0.15, 0.45, 0.75, 1.50)	0.60	0.32	1.09	7.41	100
Trichlorfon (0.125, 0.25, 0.75, 1.25, 2.5)	0.62	0.34	1.11	6.76	96
Aldicarb (0.125, 0.25, 0.75, 1.25, 2.5)	0.62	0.32	1.17	7.90	96
Thiometon (0.10, 0.20, 0.6, 1.0, 2.0)	0.80	0.43	1.47	7.35	75
Disyston (0.25, 0.5, 1.5, 2.5, 5.0)	1.05	0.52	2.11	9.76	57
Carbaryl (0.125, 0.25, 0.75, 1.25, 2.5)	1.10	0.47	2.53	11.72	54

*All the insecticides were technical grade. Chi-square values were not significant ($p > 0.05$).

for the LD_{50} values. Possibly, there may not be a significant resistance in the population for these pesticides. Of the eleven pesticides Phorate amongst the organophosphorus compounds and Zectran amongst carbamates were the most toxic. Field studies have also shown that Phorate (SANDHU & DUHRA, 1977) and Diazinon (KABIR & RAHMAN, 1973) are potent insecticides for the control of *T. nivella*. ANON. (1974–1975) is in agreement with our data that Disyston has little value in controlling this pest. Zectran which was found to have maximum toxicity has not been used for control of *T. nivella* so far and needs to be investigated for its potential in controlling this pest.

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STUDIES ON *HELIOTHIS ARMIGERA* (HUBNER) AS A PEST OF *HIRSUTUM* COTTON IN THE PUNJAB

JOGINDER SINGH & A. S. SIDHU
Department of Entomology, Punjab Agricultural University, Ludhiana, India

(*Received 28 November 1979*)

Heliothis armigera (HUBNER) is becoming a serious pest of cotton in Muktsar area because of a shift in the cropping pattern and absence of effective natural enemies of larvae under the field conditions. Larvae were active on different crops from March-November. First attack on cotton was observed in July but maximum population of _Heliothis_ larvae was found during September-October. It caused up to 33 per cent shedding of cotton squares in September. Duration of egg, larval, pre-pupal and pupal stage varied from 2.76 ± 0.43 to 5.17 ± 0.38; 13.35 ± 0.53 to 27.21 ± 3.27; 1 to 3 and 8.02 ± 0.98 to 138.4 ± 0.98 days, respectively during different months. _Chenopodium album_ L. (_bathu_) is a new weed host of this pest. Larval survival was higher on _hirsutum_ than on _arboreum_ cotton.

(*Key words: Heliothis armigera*, **cotton pest, new weed host**)

INTRODUCTION

Heliothis armigera (HUBNER) commonly known as gram pod borer (American bollworm-tomato fruit borer) is a polyphagous pest of world wide occurrence. In the Punjab, it is a serious pest of Bengal gram, tomato and *berseem* (Egyptian clover) at the seed-formation stage. However, it caused heavy damage to the cotton crop during 1977 around Muktsar. The present studies were undertaken during 1978 to ascertain the possible factors responsible for its appearance as a serious pest of cotton.

MATERIALS AND METHODS

The main cotton growing areas of the State were visited frequently to study the cropping pattern in different localities. Also the larval population of *Heliothis* was recorded from a randomly selected one square metre area of the crop. Ten such samples were taken from each field. The larvae of different ages were collected from different localities crops and reared in laboratory for record of natural enemies. The biology was studied in screen-house using tender leaves of *hirsutum* F 414 as food. The ratoon crop of the said variety was kept for food during the off season. The moths were encaged on a potted cotton plant under a split cage.

RESULTS AND DISCUSSION

Egg stage

The duration of egg stage varied from 2.76 ± 0.43 to 5.17 ± 0.38 days (Table 1). These results are in agreement with those of SRIVASTAVA & SAXENA (1958), HSU *et al.* (1960), REED (1965) and SINGH (1970).

Larval stage

Larval period was comparatively short (13.35 ± 0.53 to 13.89 ± 1.58 days) during April-July but was considerably prolonged (25.58 ± 0.96 to 27.21 ± 3.27 days) during winter (Table 1). SINGH (1970) had reported it as 8-12 days on tomato at Ludhiana. It ranged from 21.28 days on gram in U.P. (SRIVASTA & SAXENA, 1958). On cotton it was of 20-21 days as reported by REED (1965) and HSU *et al.* (1960).

The larval duration of this pest was also studied when the larvae fed on leaves of

TABLE 1. Duration of different stages of *Heliothis armigera* reared on *hirsutum* cotton F 414.

Period	Sample size	Duration (days)	
		Range	Mean ± SD
Egg stage			
April-June	89	4-5	4.41 ± 0.49
August	45	2-4	2.78 ± 0.78
September	45	2-3	2.76 ± 0.43
Oct. Nov.	34	5-6	5.17 ± 0.38
Larval stage			
April-May	19	10-16	13.89 ± 1.58
June-July	97	13-15	13.35 ± 0.53
August	35	13-18	15.00 ± 1.20
September	29	15-19	16.93 ± 0.72
Oct.-Nov.	26	24-27	25.58 ± 0.96
Nov.-Dec.	19	24-36	27.21 ± 3.27
Pupal stage			
May	16	7-11	8.56 ± 0.97
July	70	7-9	8.02 ± 0.98
September	11	6-11	8.63 ± 1.48
November-March	14	136-140	138.4 ± 0.98

different *hirsutum* (LSS and F 414) and *arboreum* (LD 133 and G 27) varieties in August, 1978. The larval development was completed in comparatively shorter period (11.5 to 14.0 days) on *hirsutum* varieties than on *arboreum* cotton. However, larval mortality was far greater (up to 43.3 per cent) on *arboreum* varieties whereas it was only upto 10.0 per cent on *hirsutum* cotton.

Pre-pupal stage

Pre-pupal period varied from 1–2 days during April-August and 1–3 days during September-November.

Pupal stage

Pupal period varied from 8.02 ± 0.98 to 8.63 ± 1.48 days during May-September. However, pupae formed during end November overwintered and took 138.14 ± 0.98 days for the emergence of adults (Table 1). REED (1965) reported that pupal stage lasted for 30–171 days whereas WILCOX *et al.* (1957) observed it to be as long as 375 days in U.S.A. These variations might be due to the prevailing environmental conditions.

Adult stage

The adult longevity was 4–6 days in April, 5–7 days in June and 6–8 days in August.

Natural enemies

Laboratory rearing of large larval collection from different crops (localities) revealed the complete absence of larval parasite, under field conditions. One unidentified dipterous larva was obtained from the larval collections from the *berseem* crop in Amritsar district. However, after the harvest of gram crop, the house sparrows (*Passer domesticus* (L.)) were observed feeding in large numbers on the exposed larvae.

TABLE 2. Population of *Heliothis armigera* larvae in different crops during different months.

Month	Crop	*No. of larvae/sq.m. in	
		Main cotton belt	Other parts of the state
March	Gram	3.3-7.3	1.7-7.3
April	*berseem*	2.8	0.3-2.1
	Lucerne	0.3	—
May	*berseem*	0-2.3	2.2-11.7
	lucerne	4.1	2.4
	tomato	4.1	5.5-14.0
June	lucerne	0.4	4.6
	tomato	3.8	4.7
	Mentha	—	0.4
	adult activity in end June on cotton crop		
July	Cotton	0-0.3	—
	Tomato	4.3-5.6	4.0
August	Cotton	0.1.5	—
	tomato	3.7-4.5	2.7-4.8
September	Cotton	0-3.0	—
October	Cotton	0-2.6	—
November	Cotton	0-1.0	—
	arhar	0.2-0.6	0.4
December	Cotton	0	—

*Mean of 10 samples. — not observed.

Host plants

Besides cotton, *Heliothis armigera* larvae were found feeding on maize, *bathu* (*Chenopodium album* L.), wheat, potato, *berseem*, *arhar* (*Cajanus cajan Millsp.*), *shaftal* (Persian clover) lucerne, tomato, *mentha*, peas and *Simla mirach*. *Bathu* is a new report as its host form India.

Population dynamics and seasonal history

The data given in Table 2 revealed that *Heliothis* larvae were present on different crops from March to November. The pest overwintered as pupae under laboratory conditions. The adults of Heliothis *armigera* were active even during day time in the cotton fields around Muktsar during end June. The first attack of the pest on cotton was observed during July and maximum larval population in cotton fields was recorded during September-October and it declined in November. No larvae were found on cotton during December.

Damage to the cotton crop

During 1977, the loss caused by this pest was so serious that the whole of cotton crop in some villages was destroyed around Muktsar. During 1978, the squares shed due to *Heliothis* were counted from different cotton growing areas. It was again maximum around Muktsar i.e. 13.46 to 32.58 per cent. No square shedding due to this pest occurred in Bhatinda and Ferozepur districts (Table 3). Negligible shedding (0.14 per cent) was caused at village Jethuke in district Sangrur.

TABLE 3. Shedding (%) of squares by *Heliothis armigera* in *hirsutum* variety F 414 at different places during September, 1978.

District	Place	*Square shedding (%) (Sq.m)
Faridkot	Sarai Naga	32.58
	Charewan	13.46
	Wadhian	6.38
	Bhagsar	1.61
	Lakhewali	1.63
Bhatinda	6 places	0
Ferozepur	4 places	0
Sangrur	2 places	0
	Jethuke	0.14

*Mean of 3 quadrats of one sq. m. each.

The possible reasons of this pest becoming serious on cotton seems to be the shift in the cropping pattern as: (a) Some farmers belonging to the areas of Rupana and adjoining villages in Muktsar area have started the cultivation of tomato. It helps the *Heliothis* population migrating from gram and *berseem* to multiply during the hot months of May and June. (b) The new *hirsutum* varieties of Bikaneri Narma and F 414 which have completely replaced the old variety LSS, start producing fruiting bodies from end May onwards. As *Heliothis* larvae prefer fruiting bodies for the dvelopment, it provides sufficient food for the survival and initial build-up of larval population. (c) The field collections of *Heliothis* larvae from different crops/localities have revealed the absence of any effective larval parasite. It may be due to large scale use of insecticides. Absence of natural enemies, however, helps in the multiplication of this pest. (d) The regular surveys of the whole cotton belt have indicated that *Heliothis* problem is confined only to Muktsar area. It might be due to heavy soil, higher water table and more vegetative growth. Wet soil is known to be more favourable for pupation and reduces pre-pual mortality due to dehydration (DITMAN *et al.* 1940). Higer vegetative growth helps in providing more congenial (high soil mosture and R.H. within the crop canopy) conditions for this pest to multiply and survive. The situation is comparable to the *Heliothis* problem on *berseem* meant for seed in Amritsar district of the state (Table 4). *Heliothis* is serious

TABLE 4. Population of *Heliothis armigera* larvae in *berseem* crop for seed in district Amritsar.

Site	Place	*Larvae Sq. m.	Average
A. High water table areas			
Batala	Jandiala	6.6	
to	Wariam	6.3	
Amritsar	Chaseet Pur	6.9	8.58
Road	Bohia	11.6	
	Nangal	11.7	
B. Low water table areas			
Baba Bakala	Chapianwali	2.0	
to Amritsar	Sathiala	0.3	0.90
Road	Mehta	0.3	
	Nutt	1.0	
Amritsar	Manawala	0	
to	Mulian	1.0	0.33
Ludhiana Road	Rayya	0	

*Mean of 10 samples (sq. m. each)

from the last many years in areas along Batala-Amritsar road which are very near to water-logged conditions. Further in thin *berseem* crop the average larval population was 2.1 larvae/sq.m. against 22 larvae from a dense and lodged crop.

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LABORATORY STUDIES ON *STURMIOPSIS INFERENS* TNS., A PARASITE OF SUGARCANE SHOOT BORER, *CHILO INFUSCATELLUS* SNELL

H. David, S. Easwaramoorthy, V. Nandagopal, M. Shanmugasundaram, G. Santhalakshmi, M. Arputhamani & N. Kunjukrishna Kurup
Division of Entomology, Sugarcane Breeding Institute, Coimbatore, India 641 007

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The parasite *Sturmiopsis inferens* Tns. completes its development in 20-49 days and the duration is subject to temperature variation. The duration of the life cycle for male and female parasite is identical at a given temperature. Freshly emerged females readily mate with 2-5 days old males and the mean copulation time was 8.1 minutes. Age of the female at mating affected the fertiity and fecundity but number of matings failed to have any effect. The mean fecundity was 196.4 and the sex raio was 1:1 to 1: 1.15 (♀ :♂). *Sesamia inferens* Walker, *Tryporyza nivella* (F), *Chilo infuscatellus* Snell, *C. partellus* Swinhoe and *Corcyra cephanlonica* Staint were the hosts attacked by this parasite in the order of preference. The flies reared on *C. partellus* showed a reduction in survival and fertility when compared to *C. infuscatellus*. In shoot borer, sex of the host did not influence the percentage parasitization or sex ratio, but affected the weight of the parasite. The weight of the host pupa positively influenced the weight of the parasite puparium and adult. A spositive correlation was observed between the adult parasite weight and fecundity.

(*Key words*: *Sturmiopsis inferens*, parasite, surgarcane shoot borer, *Chilo infuscatellus*, biology)

INTRODUCTION

The sugarcane shoot borer, *Chilo infuscatellus* Snell., first recorded in 1857 (Agarwal & Siddiqi, 1964) is one of the important species of moth borers that damages sugarcane in India (Gupta & Avasthy, 1957). In the early phase of cane growth, the larvae bore into young shoots and produce characteristic "dead-hearts" causing considerable reduction in cane population and yield (Gupta, 1953) and sugar recovery (Khan & Krishnamurthy Rao, 1954). In peninsular India, the incidence of this pest is influenced by the planting season and it attains peak infestation during March-June (Nagaraja Rao & Chandy, 1957) under high temperature and dry conditions (Kalyanaraman *et al.*, 1964; Varadarajan *et al.*, 1973) and again during September, in special season plantings (Sithanantham *et al.*, 1975). In recent years, *Sturmiopsis inferns* Tns. (Syn. *Winthemia semiberbis* Bezzi (Tachinidae : Diptera), principally a larval endoparasite of the pink borer, *Sesamia inferens* Walker (Bezzi, 1925; Krishna murthy & Usman, 1952) was noticed to attack the shoot borer in some parts of the country (Jai Rao & Hemlata Baliga, 1968). Its activity is more in Coimbatore (Anon., 1971), Rayagada in Orissa (Kalra & Dutta, 1971) and Haryana (Singh & Yadav, 1979). In this paper, observations made on the biology of the parasite with special emphasis on its reproduction, laboratory rearing and host range are reported.

MATERIALS AND METHODS

The stock culture of the parasite started with field collected puparia was maintained on larvae of shoot borer collected from fields at room temperature

of 26±1°C and RH of 80±10 per cent. All subsequent studies were conducted at 26±1°C in an air conditioned room, except temperature studies. The parasite was multiplied following the modified technique of Scaramuzza for *Lixophaga diatraeae* TNS. (MOHANRAJ & SAXENA, 1964). Generally the females were separated from males by the presence of two proclinate fronto-orbital bristles (JAI RAO & HEMALTA BALIGA 1968). A more practical and easy method is to indentify the female by the presence of conspicuous white band in the vertex, in contrast to the greyish band in male.

Third to fifth instar larvae of shoot borer and sorghum borer, *Chilo partellus* SWINHOE collected from fields were treated with 1 per cent sodium hypochlorite. Each larva was allowed to crawl on a petri dish and incoulated with two maggots. After inoculation, 5 larvae were allowed in a plastic box (7.0×7.5 cm) provided with filter a paper at the bottom to absorb excess moisture and 5 pieces (5–6cm length) of sugarcane or sorghum shoots as the case may be. The shoots were split open at one end. The filter paper and shoot pieces were changed once in 2 or 3 days after collecting the host and parasite pupae.

The development of the parasite was studied at two constant temperatures in BOD incubators. Individual host larva inoculated with parasite maggot were reared separately. The pupae of the host and parasite thus obtained were also kept individually until the parasite adult emerged and sexed and then the corresponding male and female larval and pupal periods were computed.

The effect of age of females at mating on their survival, fertility and fecundity was assessed by allowing the females to mate immediately a day after their emergence. The virgin females in the second set were kept in darkness and provided with honey for 24 hours.

The parasite was also evaluated against *C. infuscatellus*, *C. partellus*, *C. sacchariphagus indicus* (K) *S inferens*, *Tryporyza nivella* (F), *Heliothis armigera* HB., *Spodoptera litura* (HB.) and *Corcyra cephalonica* STAINT. In the case of top borer of sugarcane *T. nivella*, the infested cane was cut to a length of about 30 cm keeping the operculum in the centre. The shoot was split open near the operculum and maggots were placed on or near the larva. After inoculation, the split ends were held together with rubber bands and the shoot was planted in moist sand with the upper end sealed with wax. After 10 to 12 days, the shoot was opened and host and parasite pupae present were collected. The weight of host and parasite pupae in all the hosts were recorded and correlated.

In the case of shoot borer, the host pupae were sexed based on the position of genital opening (GUPTA, 1959) and held separately. The weight of host pupae and parasite puparia and adult were recorded and correlated separately for each sex.

The data were analysed using 't' test, chi-square test of independence, proportional's test and in completely randomised block design as indicated under respective tables.

RESULTS

Life cycle

At room temperature of 26 ± 1°C the parasite took 20 to 51 days with a mean of 33.3 and 34.3 days in males and females to complete its life-cycle.

The parasite completed its development in 20–49 days with a mean of 33 and 34.4 days respectively in males and females at 29°C (Table 1). The developmental period was shortened by a mean of 4.2 and 5.9 days in males and females respectively when reared at 31°C. Embryonic development was also rapid at 31°C as active maggots were obtained in some flies dissected on the fifth day itself. There was significant reduction in the larval and pupal period of the female parasite and in the pupal period of the male parasite at 31°C.

Mating

Freshly emerged females after shedding the meconium readily mated with 2 to 5 day old males. The mean copulation time observed on 200 females was 8.1 (range 4–30) minutes. Exceptionally one pair remained in coitus for 180 minutes, but the female died immediately after separation. If mating was induced immediately after separation, sometimes the pair mated again. However, survival, fertility and fecundity

TABLE 1. Development of *Sturmiopsis inferens* at 29 and 31°C.

Duration of stages) (in days)	Temperature (°C)						Between temperatures
	29			31			
	Range	Mean	SE	Range	Mean	SE	t. Cal.
Gestation period	7-14	11.8	0.54	5-14	9.1	0.07	**
Larval period :							
Male	6-19	10.7	0.37	5-15	10.3	0.27	NS
Female	6-22	11.6	0.69	5-15	9.9	0.32	**
Pupal period:							
Male	7-13	10.5	0.25	7-11	9.4	0.12	**
Female	7-13	10.5	0.22	7-11	9.5	0.30	**
Total :							
Male	20-46	33.0		17-40	28.5		
Female	20-49	34.4		17-40	28.5		

Compared by unpaired 't' test.
**: Significant at 1% level.
NS: Not significant.

of females were not affected by number of matings (Table 2). The newly emerged female readily mated, while one day old female rarely mated and 2 day old female failed to mate. Successful mating was obtained in 82 per cent of freshly emerged females. There was no marked difference in the survival, but significant reduction in fertility and fecundity was noticed in the females mated one day after their mergence (Table 2). The proportion of undeveloped eggs increased from 29.3 per cent in females mated on the day of their emergence to 38.4 per cent in females mated on the next day.

Fecundity

Females from field-collected puparia showed a mean fecundity of 256 active maggots. After one year of laboratory breeding the mean fecundity was found to be 196.4. The maximum number of active maggots obtained from a single fly was 580. In most of the females, a sizable proportion of the eggs that descended into the uterus, 21.9 per cent on an average, showed either partial or no development.

Adult emergence and sex ratio

Under laboratory conditions, the flies emerged throughout the day. Proportion of males was marginally greater than females and the sex ratio was 1 : 1 in the laboratory reared flies and 1 : 1.15 (♀:♂) in the flies obtained from field collected puparia. The percentage of female emergence was 46.7 for flies obtained from field collected puparia and 50.1 in laboratory and it ranged from 35 to 60 in different months (Fig. 1). How-

TABLE 2 Effect of age and number of matings on survival, fertility and fecundity of the parasite.

Age at mating					Number of matings				
Age	Number mated	Number survived	Number fertilised	Mean fecundity	Frequency of matng	Number mated	Number survived	Number fertilised	Mean fecundity
Newly emerged	50	32 (64.0)	29 (90.6)	200	1	40	23 (57.5)	17 (73.9)	221
One day old	21	15 (71.4)	10 (66.7)	191	2	33	21 (66.3)	16 (76.2)	223
		χ^2 = 0.37NS	χ^2 = 4.15*	SE = 3.63* CD = 2.48			χ^2 = 0.28NS	χ^2 = 0.03NS	SE = 4.42NS

Compared by chi test of independence
NS = Not significant

Figures in parantheses indicate percentage.

* — Significant at 5% level
CD — Critical difference.

TABLE 3. Effect of different hosts on per cent parasitization and fecundity of the parasite.

Host	No. of larvae inoculated	Number pupated	Mean pupal weight (mg)	Mean puparial weight (mg)	Per cent effective parasitization*	Mean fecundity of female
Chilo infuscatellus	48370	8323	72.7	34.0	46.3	196.4
Chilo partellus	20899	9596	79.4	40.8	35.9	252.6
Chilo sacchariphagus indicus	158	35	..	..	0.0	..
Tryporyza nivella	102	16	96.0	39.3	61.7	270.0
Sesamia inferens	175	26	123.3	48.5	84.4	322.0
Spodoptera litura	200	131	..	..	0.0	..
Heliothis armigera	130	100	..	..	0.0	..
Corcyra cephalonica	306	240	23.6	21.2	6.7**	..

* Diseased larvae were excluded.
** None of the females mated.

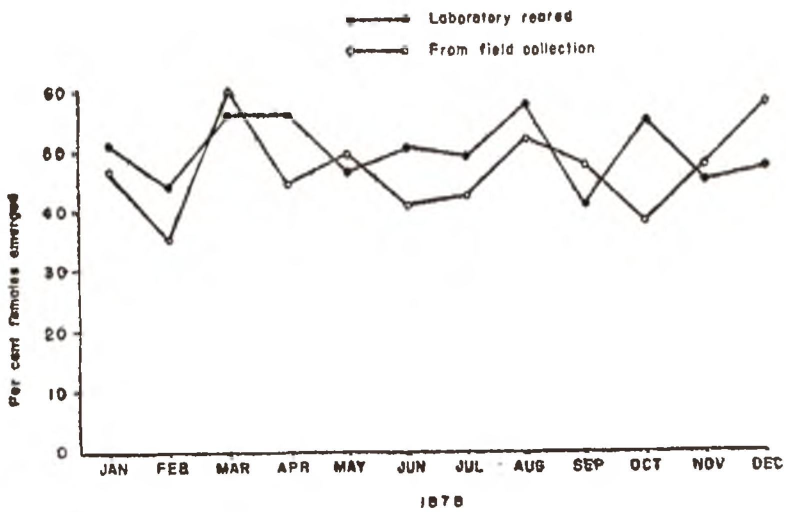

Fig. 1. Per cent emergence of females in laboratory and field during different months.

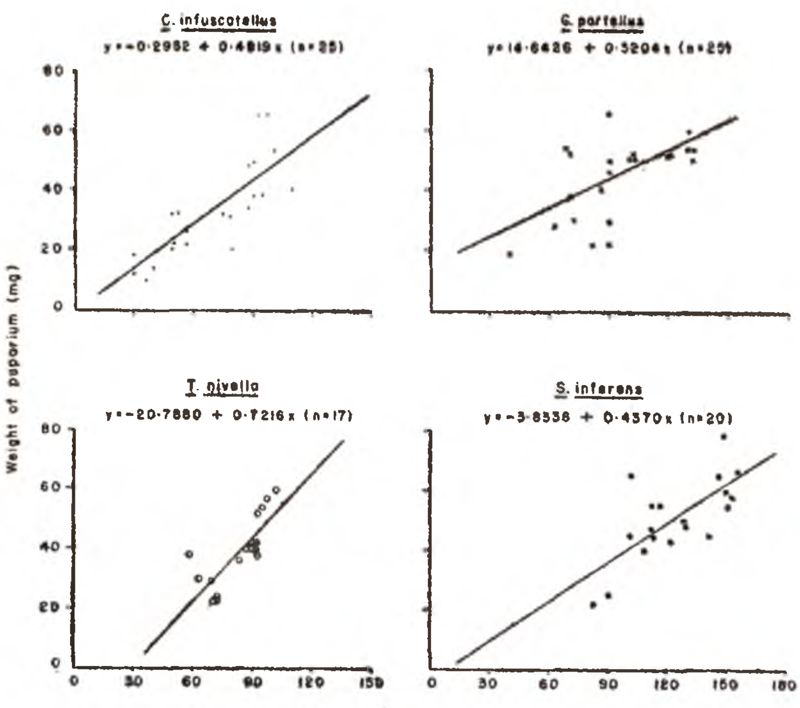

Fig. 2 Relationship between weight of host pupa and parasite puparium.

ever the differences were not statistically different.

Host range and influence of host sex

The pink borer, *S. inferens* was the most preferred host for the parasite wherein 84.4 per cent effective parasitization was recorded followed by *T. nivella* (61.7%), *C. infuscatellus* (46.3%), *C. paratellus* (35.9%), and *C. cephalonica* (6.7%) (Table 3). But it failed to parasitize *C. sacchariphagus indicus*, *H. armigera* and *S. litura*. Though parasitization was observed on *C. cephalonica* to some extent, the size of pupa and adult parasite was reduced and female flies failed to mate. A positive correlation was obtained between the weight of the host pupae and parasite puparia irrespective of the host (Fig. 2). The mean fecundity was again high in females bred on *S. inferens*.

There was considerable reduction in the survival and fertility of the females (Table 4) reared on *C. partellus* but the fecundity and puparia recovery were more when compared to *C. infuscatellus*. The total premature mortality of flies reared on *C. infuscatellus* was 28.0 per cent only, compared to 6.7 percent of flies reared on *C. partellus*.

TABLE 4. *Influence of host on parasitization, survival fertility and fecundity of the parasite.*

	Chilo infuscatellus	*Chilo partellus*
Effective parasitization (%)	61.8	33.4
Production of puparia to larvae inocuated (%)	9.5	17.1
Mating of femaes (%)	87.2	93.0
Survival of females (%)	70.3	39.3
Fertility of females (%)	72.0	55.9
Mean Fecundity	196.4	252.6

When the mortality of the females were plotted over time it indicated that mortality of the females bred on *C. partellus* was high in the first two days after emergence (Fig. 3).

With regard to the influence of host sex, no significant difference in parasitization, fly emergence and sex ratio of the parasite was observed because of the sex of the host in *C. infuscatellus* (Table 5). However, the weight of the puparia and adult parasite developed on female was more than on male host (Table 6). The weight of the host pupa directly influenced the weight of the parasite puparia (Fig. 4) which in turn influenced the adult parasite weight (Fig. 5) irrespective of the sex, whether host or parasite. Again weight of the adult parasite had a positive association with fecundity ($r = 0.3824^*$).

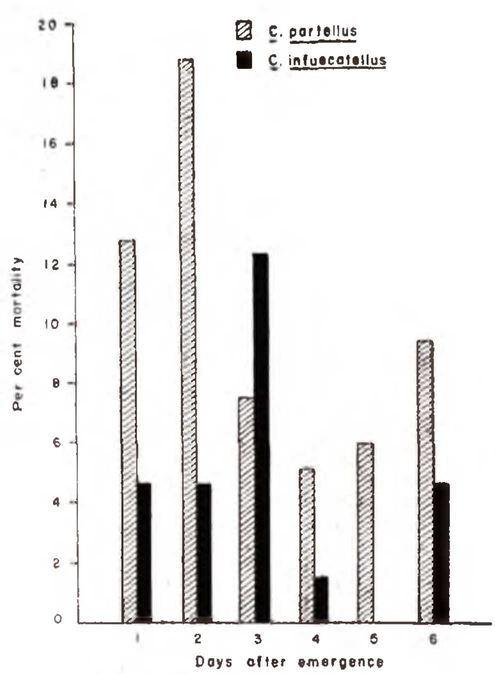

Fig. 3. Effect of host on premature mortality of the parasite

TABLE 5. Influence of host sex on *Sturmiopsis inferens* parasitization.

	Male pupa	Female pupa
Number of host pupae studied	505	410
Per cent parasitization[1]	19.4	24.9NS
Number of parasite flies emerged	81	88
Per cent fly emergence[2]	82.7	86.3NS
Female[3]	37	36NS
Male[3]	44	52NS
Sex ratio	1 : 1.19	1 : 1.44

NS: Not significant

1 and 2: Compared by proportional's test

3 : Compared by Chisquare test of independence.

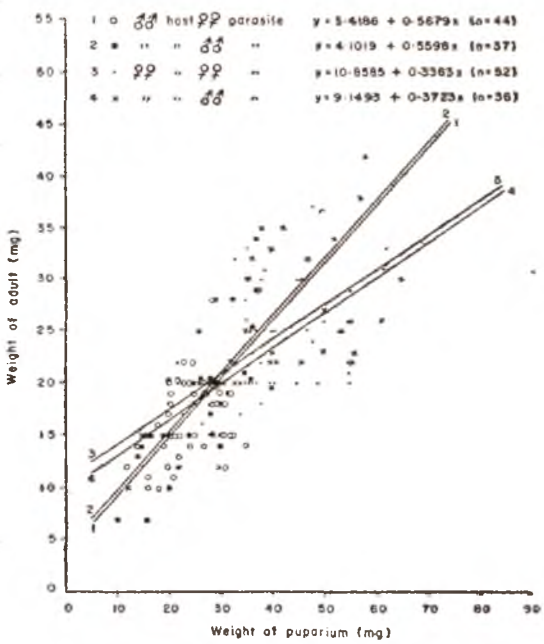

Fig. 5. Relationship between parasite puparium and adult.

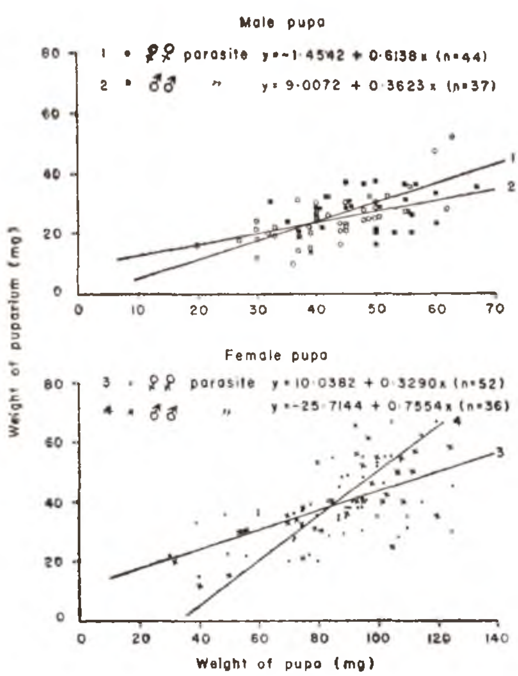

Fig. 4. Correlation between weight of shoot borer pupa and parasite puparium.

Number of maggots inoculated and parasitization

In a preliminary experiment, 200 larvae of shoot borer in each case were inoculated with 1, 2, 3 and 4 maggots per host larva. The per cent parasitization recorded was 64.3, 60.5, 46.0 and 62.5 per cent respectively and no significant difference was observed. The results of large-scale inoculation of one and two maggots per host larva recorded 46.5 and 50.1 per cent parasitization in *C. infuscatellus* and 24.6 and 31.1 per cent in *C. partellus*.

DISCUSSION

S. inferens is one of the few tachinid parasites naturally occurring in the sugarcane crop in the old world. Originally reported as a minor parasite on pink borer and shoot borer (SASTRY & APPANNA, 1958), this has now become a regulating

TABLE 6. Influence of host sex on the pupal and adult weight of the parasite.

	Weight in mg. of					
	Male host			Female host		
	Male parasite	Female parasite	Mean	Male parasite	Female parasite	Mean
Host pupa	44.2	43.0	43.6	86.0	87.2	86.7
Parasite puparia	25.0	24.8	24.9	39.3	38.7	38.9
Parasite adult	18.1	17.1	17.8	23.8	23.9	23.8

	Host Pupa		P. puparium		P. adult	
	S. E.	C. D.	S. E.	C. D.	S. E.	C. D.
Between host sex	2.44**	5.48	2.04**	4.58	1.02**	2.81
Between parasite sex		NS		NS		NS

** — Significant at 1% level
NS — Not significant.

force in sugarcane shoot borer population in Coimbatore area. Phased programme of cultivation of sugarcane to supply canes for two seasons of crushing makes available the natural host throughout the year. In nature, parasitization of the borer ranging from 4.9 to 35.6 per cent has been observed and the parasite was found active throughout the year (unpub. data).

The life cycle of the parasite in the laboratory occupies 20 to 49 days at 29°C and its duration is subject to temperature variation. Earlier work in other areas in the country showed duration of 30–42 days at 25.5 to 26.5 °C (JAI RAO & HEMLATA BALIGA, 1968) and 35 to 50 days at 27 to 29°C (KALRA & DUTTA, 1971) and 47 to 61 days (SAXENA, 1971).

Single mating is found to be sufficient for a female for fertilization of full complement of its eggs. Mating of the female immediately after its emergence ensures high maggot production as there is distinct setback in fertilization when mating occurs on the next day, after a portion of eggs have already descended into the uterus. This is in conformity with the findings reported by WILLIAMS (1967) in the case of another tachinid parasite, *Diatraeophaga striatalis* TNS.

Attempts made to breed the parasite on common laboratory hosts like *H. armigera*, *S. litura* and *C. cephalonica* have not been successful. The inability of the parasite to parasitize *H. armigera* has already been reported by BENNETT (1965). Host size considerably influences the fecundity as evidenced by larger host *S. inferens* and female host of shoot borer with higher body weight. This is due to the availability of larger quantity of food for the parasite.

When reared on the alternate laboratory host, *C. partellus*, higher premature mortality and reduction in the fertility of the parasite was observed. However, rearing the parasite over a number of generations

on *C. partellus* may remove this defect by induction of physiological adaptation. Field collection of 7,918 larvae and 782 pupae in 1977 and 15,970 larvae and 1,314 pupae in 1978 of *C. partellus* from sorghum crop did not show even a single case of parasitization. obviously indicating non-preference of *C. partellus* as an alternate field host. Top borer *T. nivella* which is parasitized to an extent of 61.7 per cent in the laboratory, cannot serve as a field alternate host, since the operculum at the exit hole blocks the entry of maggots. However, earlier observations (RAO, 1965; JAI RAO & HEMLATA BALIGA, 1968) indicate field parasitization of top borer, but no mention is made on the extent of parasitization. This might be possible when the larvae are exposed during trashing operation which facilitate exposure of larvae for parasite attack. The internode borer *C. sacchariphagus indicus*, another common pest of sugarcane in this region is not attacked by this parasite. The parasite, therefore, multiplies mainly on shoot borer and to a less extent on pink borer *S. inferens* which is a minor pest in Tamil Nadu on sugarcane and ragi.

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BRIEF COMMUNICATION

NOTES ON A COLLECTION OF ROOT-INFESTING APHIDS (HOMOPTERA : APHIDIDAE) FROM KERALA, SOUTH INDIA

C. G. A. Pai[1], N. R. Prabhoo[1], Basant K. Agarwala[2] & D. N. Raychaudhuri[2]
[1] Department of Zoology, University of Kerala, Kariavattom, India 695 581
[2] Entomology Laboratory, Department of Zoology, University of Calcutta, Calcutta, India 700 019

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Rhopalosiphum padi **from roots of grass in the paddy field,** ***R. rufiabdominalis*** **from the roots of paddy and** ***Tetraneura nigriabdominalis*** **from roots of grass in an uncultivated plot are recorded from Kerala.** ***R. padi*** **and** ***R. rufiabdominalis*** **are reported for the first time from this state. These aphids were found to be rare components of the soil biota.**

(*Key words:* **root aphids, distribution, fauna**)

Examination of a small collection of aphids from the root system of grass and paddy revealed three species viz. *Rhopalosiphum padi* (L), *R. rufiabdominalis* (Sasaki) and *Tetraneura nigriadominalis* (Sasaki). Of these *T. nigriabdominalis* (Sasaki) was already reported from Kerala (David, 1958) and *R. rufiabdominalis* (Sasaki) from Tamil Nadu (David, 1956). Brief notes on these three species are provided in this report.

1. Rhopalosiphum padi (L.)

Material examined: 1 apterous viviparous ♀, India: Kerala: Kazhakkutom, 31. i. 1980 from soil with grass roots from paddy field, Coll. C.G.A. Pai.

Remarks: David and Ghorpade (1974) reported the above species from Andhra Pradesh found to be infesting the aerial parts of *Scripus* sp. In North-East India this species is known to infest grass roots.

2. Rhopalosiphum rufiabdominalis (Sasaki)

Material examined: 1 apterous viviparous ♀ and nymphs, India: Kerala: Kazhakkuttom, 31. i.1980, from soil with roots of paddy, coll. C.G.A. Pai.

Remarks: This species is known to infest roots of *Eleusine coracana* and *Echinocloa colona* (Graminae) in Tamil Nadu during September to November and the aerial parts of *Eleusine coracana* during May-June (David, 1956).

In the adult apterous viviparous female examined in this study, the abdomen was found to possess a few hairs with furcated apices along with hairs characteristic of the species. Variations in the length and shape of the hairs in root infesting forms of aphids is not uncommon.

3. Tetraneura nigriabdominalis (Sasaki)

Material: 2 apteroid nymphs, India: Kerala: Kazhakkuttom, 4. ii. 1979. from soil with grass roots from the uncultivated field, coll. C.G.A. Pai.

Remarks: David (1958) recorded this species from Pattambi, Central Kerala, during October under the name *T. hirsuta* (Baker) from aerial parts of *Eleusine coracana* at the level of soil surface. Earlier David (1956) noted this species in Coimbatore in June on the aerial parts of *Echinocloa colona*.

Ecological notes: The three species of aphids listed above were found to occur in very few soil samples and in very small numbers both in the paddy field and adjoining uncultivated field. The paddy field remains inundated from June to December every year. This condition is not suitable for the existence of root aphids. These aphids therefore form only minor pests of paddy.

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ERPOBDELLID LEECH AS A POTENTIAL PREDATOR OF LARVAL *CULEX* IN KERALA

C. G. A. PAI & N. R. PRABHOO
Department of Zoology, University of Kerala, Kariavattom, India 695581

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The leech *Herpobdelloidea* occurring in paddy fields in Kerala feeds on *Chironomus* larvae in nature In the laboratory it fed also on larvae of *Culex fatigans* when offered alone or along with *Chironomus* larvae. The study indicated the potentiality of the leech as a predator of larval mosquitoes for the first time.

(*Key words:* **mosquito, leech, predation).**

A number of investigations on the natural enemies of mosquitoes and other biting flies brought to light several aquatic predators belonging to different groups of animals (ANONYMOUS, 1975). In India predatory insects of mosquito larvae belonging to Heteroptera (PANICKER & RAJAGOPALAN, 1977) and Odonata (MATHAVAN, 1976, 1979) and certain indigenous fishes (REDDY & PANDIAN, 1974; MENON & RAJAGOPALAN, 1977) received particular attentoin. Such primitive forms like *Hydra* (ANONYMOUS, 1975) and flatworms like *Dugesia dorotocephala* (LEGNER, 1977) and *Mesostoma* (CASE & WASHINO, 1979) are among the invertebrate predators of mosquito larvae reported from different parts of the world. Each one of these predators is efficient only in certain environments. As the mosquitoes breed in a wide variety of habitats it would be necessary to look for more predators so that competent ones could be used against the mosquito under a particular set of conditions.

To the best of our knowledge the potential of leeches as predators of larval mosquitoes has not been reported. Predatory leeches are, however, known (MOORE, 1927) to feed on worms including other leeches, insect larvae, molluscs and other invertebrates some of which affect human interest. The glossiphonid leeches *Helobdella stagnalis* (L) and *Helobdella nepheloides* (GRAF), which occur abundantly in the lake Winnebago in Wisconsin (USA) have been established (HILSENHOFF, 1963, 1964) to be feeding extensively on the larvae of *Chironomus plumosus* (L) (Syn: *Tendipes plumosus* (L)).

In the present study an erpobdellid leech *Herpobdelloidea* was found to occur in a paddy field at Kazhakkutam near the University Campus, during August- September period when the field had standing water 10-15 cm deep. In permanent mounts of the leeches, larvae of *Chironomus* were observed in the gut of the former. This prompted us to see whether the leeches could feed and thrive on mosquito lravae.

Herpobdelloidea collected from the field were brought to the laboratory and kept in 1000 ml beakers containing one third water. The leeches were starved for 48 hours and were provided with 20 *Chironomus* larvae having a mean length of 4.57 mm or with 20 larvae of *Culex fatigans*, with a mean length of 4.83 mm. In another observation 20 each of the two types of larvae were given

to a pair of leeches. Consumption of larvae was noted for 24 hour periods. Observations were continued for 12 days. The larvae consumed were replaced by fresh ones keeping the number of the prey constant at the beginning of the day.

The individuals of the leech employed had the following standard measurements (MOORE, 1927), expressed as mean of the measurements of six individuals. Length of body = 16 mm, length on maximum stretching of the animal = 24 mm, buccal width = 345 μm, diameter of the caudal sucker = 780 μm, maximum width of the region of food = 977 μm, length of male pore from the anterior end = 3.3 mm, width at male pore = 707 μm and width at anus = 946 μm.

In the course of 24 hours the mean number of *Chironomus* larvae and *Culex fatigans* larvae consumed by a leech was respectively 12 and 8. When supplied with *Chironomus* and *Culex* larvae together, a pair of leeches consumed 10–13 and 3–5 respectively of the two types of larvae. Larvae of *Chironomus* and early instars of *Culex* are consumed as a whole. But only the body contents of late instar mosquito larvae were sucked in by the leeches discarding the exoskeleton and in some cases also the entire head. The leeches also apparently showed a preference for later instars (II – IV) than the earlier one, though this remains to be established by more carefully planned experiments.

Leeches are generally known to be predators of aquatic invertebrates (BAY, 1974.) The predatory nature of *Herpodelloidea* has been indicated earlier (MOORE, 1927) and is supported by the observation of *Chironomus* larvae in the gut of individuals collected from the field during the course of the present study. Since under experimental conditions this leech was found to feed on larvae of *Culex fatigans* when supplied alone or in the presence of *Chironomus* larvae, it can be presumed that the leeches can feed on the larvae of mosquitoes breeding in the paddy field. Again as the leeches can either swallow the earlier instars of mosquito larvae or suck the body contents of the later instars, absence of mosquito larvae in the gut of the leech does not exclude the possibility of its feeding on the larvae. The present study suggests that the leech *Herpodelloidea* can act as a predator of larval mosquitoes and other biting flies and from the number of larvae eaten by the leech per day it appears that this leech can cause considerable mortality in the larval population of the flies. It is also noted in this study that the leech can feed larger numbers of *Chironomus* larvae than *Culex fatigans* larvae of comparable mean length. The ability of *Herpobdelloidea* to control larval mosquitoes and chironomids has to be tested in the laboratory as well as in the field before anything definite can be said about the value of this leech as a biological control agent.

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A NEW SPECIES OF *TOMOCERUS* (S. STR.) (TOMOCERIDAE : COLLEMBOLA) FROM INDIA

N. R. PRABHOO & V. MURALEEDHARAN
Department of Zoology, University of Kerala, Kariavattom, India 695 581

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A new species of Collembola, *Tomocerus* (S.Str.) *mitrai* has been described from the North West Himalayas in India. It rsesembles *T. vulgaris* and *T. spinistriatus* in the possession of coloured and striated dental spines, but is distinguishable from the two species in having only two setae on th corpus of the tenaculum.

(*Key words:* *Tomocerus*, **Collembola, systematics**).

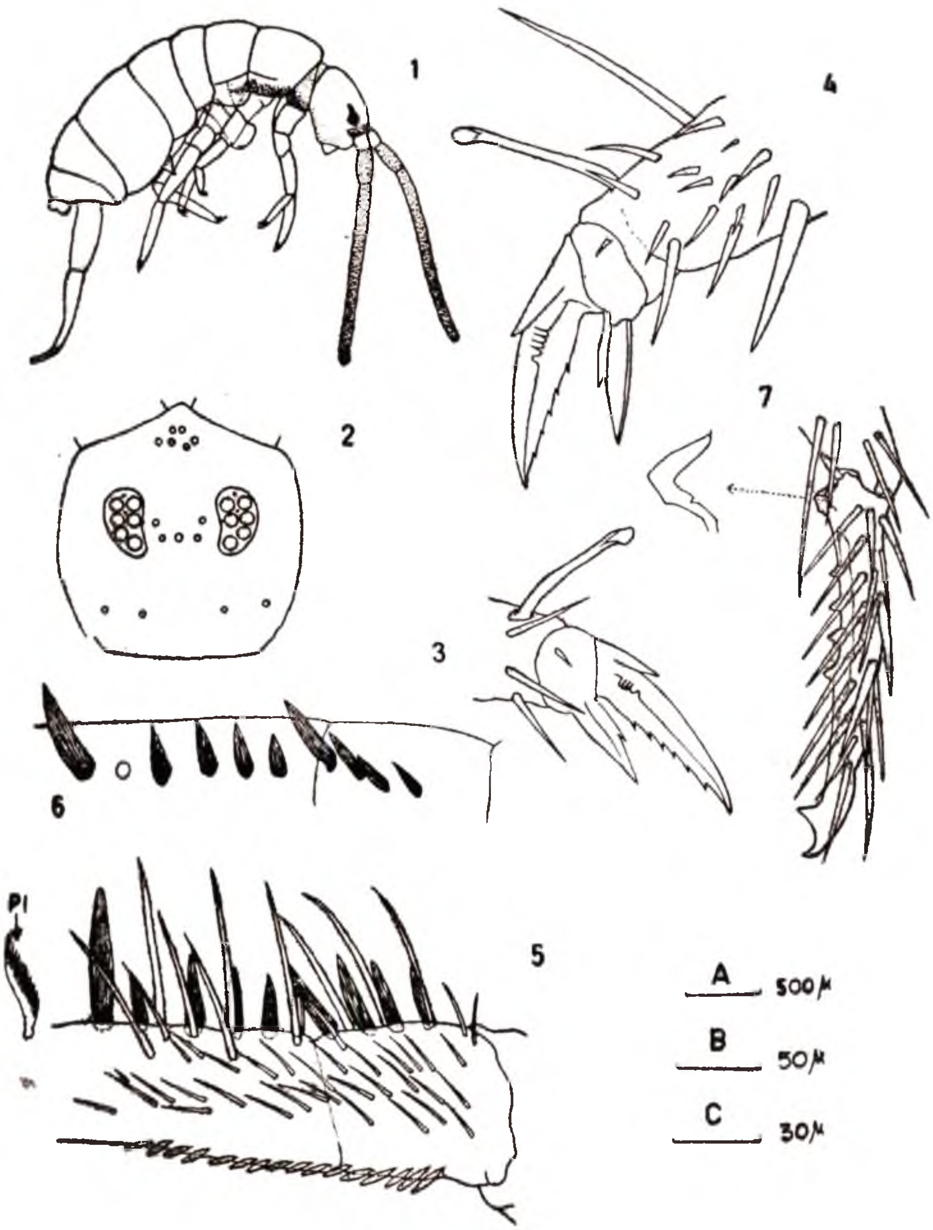
Asiatic species of Tomoceridae have been dealt with in the comprehensive studies of Yosii (1967) with special reference to Japanese forms and of Lee (1974, 1975) with special reference to Korean forms, besides in a few other isolated studies. The taxonomic importance of the various morphological features of *Tomocerus* and other genera of Tomoceridae has been critically evaluated by Yosii (1967). Only the genus *Tomocerus* under the family Tomoceridae has been known from the Indian subcontinent, eight species of which were reported by various authors viz., Imms (1912), Singh *et al.* (1955), Yosii and Ashraf (1965), Yosii (1966, 1971) and Salmon (1969). Of these eight species, *Tomocerus simplex* Yosii (1966) belongs to the subgenus *Tomocerina,* while the remaining seven species belong to *Tomocerus* (s. str.). The form included in the present study is found to be sufficiently different from known species of *Tomocerus* (s. str.) and hence is described here as a new species.

Tomocerus (s. str.) **mitrai**[1] sp. nov. (Figs. 1–7)

Body 3.7 mm long. Ground colour yellowish white. Ocellar fields deep blue. Light blue pigment towards the lateral margin of the thorax and ventral side of the head. Ant. I apparently devoid of pigment; ant. II–III with progressively more pigment from base of ant. II to the apex of ant. III. Rest of the body including the thoracic and abdominal appendages devoid of pigment. Body clothed with brownish blunt scales with prominent striations and small finely ciliated and pointed setae. Ant. I – II with both scales and setae. Ant. III with only setae arranged in whorls. Legs with both scales and setae. Scales were not observed on the ventral tube. Manubrium dorsally with scales and some setae and laterally with a row of setae. Dentes with plain and ciliated seate dorsally, plain setae laterally and with scales on the ventral side. Towards the distal half of the dens are two rows of unilaterally plumose setae, 8–10 in a row.

Head has a fringe of spine-like setae on the hind margin and a fringe of normal setae anteriorly around each antennal base. Macrochaetae are few and in the forntal region

[1] Named after Dr. S. K. Mitra in appreciation of his contribution to the knowledge of Indian Collembola



Scale is given in bracket. 1. Habitus (A); 2. Dorsal side of the head showing ocelli and chaetotaxy (diagrammatic); 3. Fore claw (C); 4. Hindclaw (C); 5. Outer view of the basal part of dens (B), Pl. Plumose seta on the distal half of dens; 6. Inner view of the basal part of dens showing the arrangement of dental spines (B); 7. Outer view of mucro (C).

they are arranged as 2, 4 setae anteriorly and five setae in the interocular region. 'p' setae 2 + 2 in the posterior region. 'v' setae and 'c' setae absent.

Antennae more than three times the head diagonal; ant. III annualated; segments related as 5:7:39; ant. IV missing. Ocelli 6 + 6, subequal. Labral setae 4/5, 5, 4. Unguis of the usual type with 6, 5, 5 inner teeth. Unguiculus lanceolate with a tooth on the inner margin. Tenent hair of the usual type and as long as the inner margin of the unguis. Spiny setae of the tibiotarsus 4, 4, 3. Trochanteral organ consisting of a plain seta. Ventral tube with many setae. Rami tenaculi quadridentate; corpus with only two setae. Furcula ratio 3:4:1. Dental spines coloured brown, finely striated longitudinally and arranged in a single row as 3, **1**/5, **1**. Mucro elongate with four intermittent teeth on the outer lamella and two basal teeth. Outer basal tooth of mucro with a corner toothlet.

Material: **Holotype** 1 example, INDIA: HIMACHAL PRADESH: Kulu—Manali road, from litter and moss by the side of a stream, altitude ca. 1800 m, coll. N.R. Prabhoo, on 11. x. 1979.

Remarks: The new species described above resembles *T. vulgaris* (Tullberg) (Yosii, 1967) and *T. spinistriatus Lee* (1975) in the nature of the dental spines, which are simple, coloured and ciliated. The number of spines is 13–15 and 15–18 respectively in the latter two species, while in the new species there are only ten of them. It is possible that the number of spines could be larger and would fall in the ranges described above when more individuals of the new species are available. The arrangement of spines shows some differences. Thus in *T. vulgaris* the spines in the proximal half of the dens are small and arranged in two rows. In both *T. spinistriatus* and *T. mitrai* there is only a single row of spines in the proximal half of the dens and the distalmost spine is much larger than the rest. The arrangement of dental spines in *T. spinistriatus* is like 5–6, **1**/6–7, **1**. The number of setae on the corpus of the tenaculum are only two in *T. mitrai,* while there are 8–10 setae in *T. vulgaris* and about a dozen setae in *T. spinistriatus.* Only the antennae besides the ocelli, in the latter two species are known to be pigmented. The claw of *T. spinistriatus* has 5–7 teeth and mucro has 6–7 intermittent teeth. In *T. mitrai* the claw has 5–6 teeth and mucro has only 4 intermittent teeth. In both *T. spinistriatus* and *T. mitrai* the unguiculus has one tooth, while the same is absent in *T. vulgaris.* It appears that *T. vulgaris, T. spinistriatus* and *T. mitrai* are a group of related species distinguishable on the basis of the combination of characters as indicated above. *T. vulgaris* is recorded by Imms (1912) from Badrinath in the Himalayas and *T. spinisttriatus* is described from South Korea by Lee (1975).

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EFFECT OF DIFLUBENZURON ON PUPAE OF TOBACCO CATERPILLAR, *SPODOPTERA LITURA* F.

R. NATESAN & M. BALASUBRAMANIAN
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, India 641 003

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Experiments were conducted to find out the effect of diflubenzuron (1-(4- chlorophenyl)-3-(2,6-difluorobenzoyl) urea) on pupae of tobacco caterpillar, *Spodoptera litura* F. Dipping of pupae in diflubenzuron solution for 10 seconds, caused pupal mortality, partial emergence and malformed adults. Susceptibility of pupae decreased with increase in their age.

(*Key words*: **diflubenzuron, pupa,** *Spodoptera litura*)

INTRODUCTION

Diflubenzuron (Dimilin (R), 1-(4- chlorophenyl) -3-(2, 6-diflurobenzoyl) urea) is a novel insecticide which interferes with chitin deposition in insects and causes difficulty in moulting. Diflubenzuron showed larvicidal activity by oral uptake (TAMAKI & TURNER, 1974; ASCHER & NEMNY, 1976) and ovicidal activity (SALAMA & EL-DIN, 1977). Experiments were conducted to find out the effect of diflubenzuron on pupae of *Spodoptera litura* F. and the results are presented here.

MATERIALS AND METHODS

S. litura was reared in the laboratory on leaves of castor, *Ricinus communis* L. Various concentrations of diflubenzuron were prepared, on the active ingredient basis, by suspending 25% wettable powder of Dimilin (R) in distilled water and stirring with a glass rod. The pupae were dipped in different concentrations of the chemical for 10 seconds, air dried and kept in glass tubes (7.5×2.5 cm) individually which were plugged with cotton. A contol was run by dipping the pupae in distilled water alone for the same period. Experiments were conducted with one, three and seven day old pupae with ten pupae for each treatment which were replicated thrice.

RESULTS AND DISCUSSION

The data on the effect of diflubenzuron on adult emergence by dipping the pupae of *S. litura* are presented in Table 1. The results revealed that all concentrations of diflubenzuron significantly reduced the adult emergence. Adult emergence was minimum at 1000 ppm. The treatments 250 and 100 ppm; 100 and 80 ppm; 80, 60 and 40 ppm and 60, 40 and 20 ppm did not differ significantly among themselves.

One day old pupae were more susceptible, recording a mean of 37.67% adult emergence than three and seven day old pupae which recorded 55.67 and 83.33% adult emergence, respectively. All the three types of pupae, differed significantly to diflubenzuron treat-

Fig. 1. Partially emerged adults with intact pupal skin.

TABLE 1. Effect of Diflubenzuron on pupae of *S. litura* adult emergence (Figures in parentheses are arc sin $\sqrt{\text{percentage}}$ transformed values).

Sl. No	Treatments	Percentage of adults emerged in			
		One day old pupae	Two day old pupae	Seven day old pupae	Mean
1.	Diflubenzuron 1000 ppm	3.33 (7.38)	20.00 (36.64)	70.00 (57.08)	31.11 (33.70)
2.	.. 500 ppm	6.67 (12.96)	33.33 (35.27)	70.00 56.90)	36.67 (35.04)
3.	.. 250 ppm	16.67 (30.60)	36.67 (37.28)	76.67 (61.30)	43.33 (43.06)
4.	.. 100 ppm	23.33 (35.52)	43.33 (41.21)	80.00 (63.51)	48.89 (46.75)
5.	.. 80 ppm	26.67 (34.39)	50.00 (45.06)	86.67 (68.94)	54.44 (49.66)
6.	.. 60 ppm	26.67 (34.39)	60.00 (50.93)	86.67 (68.94)	57.78 (51.42)
7.	.. 40 ppm	36.67 (37.28)	60.00 (50.93)	83.33 (66.22)	60.00 (51.44)
8.	.. 20 ppm	53.33 (39.29)	66.67 54.87)	90.00 (71.66)	70.00 (55.27)
9.	.. 10 ppm	83.33 (66.74)	86.67 (68.94)	90.00 (75.05)	86.67 (70.24)
10.	Control	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
	Mean	37.67 (38.85)	55.67 (51.10)	83.33 (67.96)	

Comparison of significant effects

Level of significance CD (P = 0.05)

1.	Between treatments	P = 0.01	4.58
2.	Between age of pupae	P = 0.01	2.50
3.	Treatments x age of pupae	P = 0.01	7.93

Fig. 2. Pupal skin has been split but adult was unable to emerge out.

ments. The interaction between concentrations and age of pupae was also significant.

Diflubenzuron also caused pupal mortality. Partial adult emergence with intact pupal skin (Fig. 1) was also observed. Such adults died within two days of their emergence. In some cases the pupal skin was split but the adults were unable to emerge (Fig. 2). Even if the adults emerged, they were malformed with crippled wings which died within two days (Fig. 3).

Fig. 3. Normal adult and malformed adults with crippled wings.

Diflubenzuron thus caused pupal mortality, partial emergence and malformed adults. Similar results were obtained by RIZK & RADWAN (1975) and FLINT & SMITH (1977) against pink bollworm. Diflubenzuron might have affected the eclosion process. However, it needs be confirmed by further investigation.

Acknowledgement : Supply of test chemical by M/s Mysore Insecticides and Co., Madras is fully acknowledged.

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CONSUMPTION AND UTILIZATION OF *DROSOPHILA* FLIES BY *HUMBERTIELLA SIMILIS* G. TOS. (DICTYOPTERA : MANTIDAE)

R. K. Sidhu & S. D. Misra
Zoology Department, University of Jodhpur, Jodhpur, India 342 001

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Consumption index, growth rate, digestibility, gross efficiency and net efficiency of carnivorous *Humbertiella similis* (Mantidae) feeding on *Drosophila*, are presented.

INTRODUCTION

A study of the interaction between an insect and its food requires measurements of rate of food intake, digestibility, and efficiency of conversion of food into body substance. The effect of environmental stress and comparison of the utilization of different foods is also permitted by these data. Studies on the quantitative food utilization are extremely meagre in carnivorous insects, unlike nutritional studies on phytophagous insects for example by Wolcott (1924), Soo Hoo & Fraenkal 1966), Delvi (1972) and Muthukrishnan & Delvi (1973). Therefore, in the present study an attempt has been made to obtain information on the consumption and utilization of food during postembryonic development by the praying mantis, *Humbertiella similis.*

MATERIALS AND METHODS

The experiment began with 30 nymphs on their emergence from the ootheca. They were kept isolated in individual tubes (6"×2") in which they were fed on *Drosophila* flies reared in the laboratory for this purpose. The nymphs were weighed every day and so also the *Drosophila* flies offered to them as their food. On the following day the remains of *Drosophila* flies left uneaten were carefully picked up and weighed to find out the amount eaten. By weighing a parallel sample, all the weights of fresh material were converted into dry weights. The total dry matter ingested was calculated by deducting the oven-dry weight of residual food from the oven-dry weight of the food offered. Cumulative weights of oven-dry faeces deducted from the cumulative weights of oven-dry food ingested gives the progressive utilization of the food. The rate of food ingested and faeces voided were determined by running averages. These basic measurements were used in computing consumption index (CI), relative growth rate (RGR), approximate digestibility (AD), and efficiency of conversion of ingested and digested food to body substance (ECI and ECD) as proposed by Waldbaur (1968).

RESULTS AND DISCUSSION

Results of th's investigation are presented in Table 1. Data obtained on nymphal period indicate that the female moulted nine times whereas in males there were only 8 moults and the duration of instars in two sexes were also different. The average duration of various instars in 15 females and 12 males are given in Table 1. As evident from the table, the duration of instars upto the fifth is more or less equal in both the sexes. Thereafter the males took progressively longer time to moult than the females.

The amount of food consumed increased as the nymphs entered later stage of development.

Consumption Index (CI) is the amount of food ingested in relation to the mean body

TABLE 1. Consumption and utilization of *Drosophila* flies by different developmental stages of *Humbertiella similis*. Values based on dry weights (N=30) (00-12; 00—15)

Instar	Duration of nymphal period (days)		Consumption Index CI±SD (mg)		Growth rate GR±SD (mg)		Approximate digestibility AD±SD (mg)		Gross Efficiency ECI ±SD (mg)		Net Efficiency ECD±SD (mg)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
I	7.13	7.08	0.69± 0.036	0.73± 0.06	0.09± 0.02	0.10± 0.05	79.19± 3.34	80.17± 3.25	14.24± 5.16	15.29± 2.22	18.09± 6.74	19.36± 5.44
II	9.14	8.64	1.02± 0.174	1.02± 0.08	0.11± 0.02	0.10± 0.02	80.7± 0.95	81.09± 7.73	11.35± 3.76	9.08± 4.11	14.08± 4.87	12.32± 4.72
III	10.31	10.5	1.00± 0.11	1.01± 0.10	0.08± 0.04	0.07± 0.04	78.91± 0.40	79.38± 2.07	5.36± 1.23	7.02± 2.33	9.99± 1.82	8.88± 2.99
IV	10.33	10.22	1.03± 0.035	1.10± 0.07	0.09± 0.03	0.07± 0.01	73.76± 2.12	73.9± 0.74	3.81± 0.76	7.03± 2.46	10.92± 4.2	9.95± 3.25
V	25.80	25.75	1.01± 0.031	1.07± 0.02	0.03± 0.00	0.03± 0.01	72.86± 0.75	73.02± 0.96	2.78∓ 0.97	2.64± 0.97	3.78± 1.27	3.63± 1.34
VI	15.22	26.71	1.03± 0.031	1.00± 0.00	0.05± 0.02	0.02± 0.01	74.67± 0.22	74.41± 0.190	5.12± 1.80	2.21± 0.96	6.88± 2.45	3.00± 1.20
VII	15.88	29.75	1.33± 0.156	0.97± 0.03	).05± 0.01	0.02± 0.00	77.83± 0.98	70.03± 1.79	3.62± 2.15	1.10± 1.5	4.70± 2.81	2.00± 1.80
VIII	25.38	31.0	1.23± 0.177	1.01± 0.01	0.03± 0.01	0.02± 0.01	59.17± 10.98	52.34± 7.22	2.49± 0.95	2.04± 0.54	4.29± 1.99	4.00± 1.25
IX	34.86	x	1.16± 0.098	x	0.02± 0.00	x	54.49± 5.89	x	1.65± 0.71	x	8.54± 1.87	x

weight of nymphs during feeding period. The rate of consumption increased from first to last instar but in females the CI decreased after seventh instar. The rate of intake by male and female was not significantly different in the different stages of development except in last two instars.

Relative growth rate (GR) explains how much of dry matter increased in the body of the animal per day per mg body weight. The first and second instar nymphs showed highest growth rate in both sexes and thereafter it decreases in successive stages of development.

A comparison of digestibility (AD) of different instars revealed that last instar always digested less food for its utilization. The overall digestibility for entire nymphal phase is presented in Table I. It is apparent that females digested higher amount of food throughout the nymphal development as compared to males.

Efficiency of conversion of ingested and digested food (ECI and ECD) also varied considerably with the advancement of nymphal instars. Both ECI and ECD decrease gradually from first instar to the last one.

The data on different growth indices collated in Table I, reveal that (i) the CI and GR did not differ markedly among the males and females of the corresponding life stages; (ii) The approximate digestibility decreased from 79.19 and 80.17 per cent in first instar to 54.49 and 52.34% in the last nymphal instar and the difference among the males and females become marked only during sixth stage; (iii) The ECI and ECD was markedly different among the individuals of two sexes throughout the development.

The carnivorous *Humbertiella similis* exhibits far higher AD than the herbivorous insects (MUTHUKIRSHNAN et al., 1976). Mean digestibility values available in the literature averages to 32% for the herbivorous acridids and to 86% for the carnivores. The fact that all carnivorous insects exhibit significantly higher (79 to 80%) efficiency than all the herbivores is because the availability of food energy per unit area will be relatively more for herbivores than for carnivores. The carnivores assimilate the limited food with greater efficiency (WEIGERT, 1965) because the food is a more limiting factor for them as compared to herbivores.

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BRIEF COMMUNICATION

STUDIES OF INSECT PATHOGENS ON MANGO LEAF WEBBER, *ORTHAGA EUADRUSALIS* WALKER (LEPIDOPTERA : PYRALIDAE)

R. P. SRIVASTAVA & P. L. TANDON
Central Mango Research Station (IIHR), Lucknow, India 226 006

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During the course of survey in 1978-79 in 17 districts of Uttar Pradesh to know the natural enemies of *Orthaga euadrusalis*, three types of insect pathogens namely *Serratia marcescens*, a bacterium; *Aspergillus flavus* and *Beauveria bassiana* the entomogenous fungi were isolated and prurified. On the basis of pathogenicity test, it was observed that *S. marcescens* gave cent per cent kill within five days. Pathogenicity tests conducted with *B. bassiana* shared cent per cent kill within 4 days in case of crawling method and within 6 days in case of spraying method. The fungus, *A. flavus* proved to be pathogenic on this pest and gave cent per cent kill within 8 days.

(*Key words: Orthaga euadrusalis*, **mango leaf webber, natural enemies, insect pathogens, entomogenous fungi)**

In order to study the insect pathogens of mango leaf webber, *Orthaga euadrusalis* WALKER, survey was conducted during 1978–79 in 17 districts of Uttar Pradesh. The pest was found serious in Lucknow, Barabanki, Unnao and Sitapur districts. As a result of survey three pathogens i.e. *Serratia marcescens* (Bacterium), *Aspergillus flavus* and *Beauveria bassiana* (fungi) were isolated and preliminary evaluation made.

1. *Serratia marcescens* Bizio.

A bacterial disease of *O. euadrusalis* was observed during 1978–79 in a mango orchard at Behta village in Lucknow. A large number of diseased and dead caterpillars were collected from the fields in sterile glass tubes for further studies. The dead caterpillars were shrivelled and light pinkish in colour. Microscopic examination revealed the presence of rod shaped, non sporulating pigmented bacteria in the body contents. The red pigmented bacterium was isolated on nutrient agar medium.

Fig. 1. *Aspergillus flavus* infected (below) and healthy (above) larvae of *Orthaga euadrusalis*.

Pathogenicity tests were made by dipping the mango leaves in bacterium water suspension prepared from a 48 hour old culture. Fifteen healthy caterpillars were released on

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these leaves and the same number of caterpillars were kept as check and were released on mango leaves sprayed with water and kept separately to avoid contamination. Observations were recorded on the disease development and mortality of the test insects. The larvae stopped feeding after 24 hours indicating the loss of appetite. Death started on 3rd day and by 5th day cent per cent mortality could be obtained. The bacterium was reisolated from infected larvae. This bacterium is a new record on *O. euadrusalis*, although, it has been reported to be pathogenic on large number of lepidopterous larvae (NARAYANAN & JAYARAJ, 1974; TANDON & SRIVASTAVA, 1978).

2. *Aspergillus flavus* Link

Larvae of *O. euadrusalis* infected by *A. flavus* were collected from fields during survey as well as from the laboratory culture. Diseased insects were collected in sterilized glass tubes for further studies. The fungus was isolated and purified on potato dextrose agar medium. The conidiophores are upright, simple, terminating in a globose or clavate swelling bearing phialides at the

Fig. 2. *Beauveria bassiana* (Bals) Vuillium infected (below) and healthy (above) larvae of *O. euadrusalis*.

apex; conidia are single celled, globose attached in basipetal chains.

The pathogenicity tests were made by allowing the healthy learvae to crawl over the dense sporulating culture of the fungus for half an hour and then released in cages containing fresh mango leaves. The insects were ill at ease after 48 hours and failed to respond to external stimuli. Death occurred within 4–8 days after infection (Fig.1). *A. flavus* is a highly entomopathogenic fungus and had been reported on many lepidopterous pests (David, 1964; Oblisami *et al*, 1969; Muthukrishnan & Rangarajan, 1974).

3. *Beauveria bassiana* (Bals.) Vuillium

An entomogenous fungus, *Beauveria bassia-ana* was isolated from the diseased specimens of mango hopper, *Idioscopus clypealis* (Srivastava & Tandon, 1978). The pure culture of *B. bassiana* obtained from hoppers was tested for its pathogenicity against larvae of mango leaf webber by two methods viz., crawling and spraying.

Crawling method: Healthy caterpillars were allowed to crawl over the dense sporulating culture of the fungus for 10 minutes and then placed in a jar containing the fresh mango leaves. In case of control healthy larvae were allowed to feed the mango leaves. The experiment was replicated five times with 10 larvae each. The experiment was carried out at 70% relative humidity and at a temperature of 25 ± 1°C.

Spraying Method: Healthy caterpillars were starved for six hours. The spore suspension was made in a medium of sterile distilled water. Dry milk powder was used as sticker. The spore suspension was sprayed on the fresh mango leaves and healthy caterpillars were allowed to feed on them in a glass jar. Experiment was replicated five times with 10 larvae each. Within 48 hours after treatments the caterpillars became lethargic, failed to respond to food and other stimuli. In case of crawling cent per cent mortality was given within 4 days whereas in spraying, it took six days. Microscopic examination revealed the presence of spores and mycelia in abundance inside the body. These caterpillars became mummified and brittle, few days after the death imparting whitish coloration to the caterpillars (Fig.2). Earlier this fungus has been recorded on large number of lepidopterous pests (Petch, 1926; Lefebure, 1931; Rao, 1975).

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RELATIVE EFFICACY OF SOME INSECTICIDES AGAINST LUCERN WEEVIL, *HYPERA VARIABILIS* (HBST.)

B. M. GUPTA, A. K. MATHUR & S. K. SHARMA
Agricultural Research Station Durgapura, Jaipur, India 302 004

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The efficacy of some insecticides, dimethoate, endosulfan, fenvalerate, formothion, leptophos, malathion, methamidophos, methyldemeton, monocrotophos, phosalone, phosphamidon and phoxim each at 0.05 per cent concentration were studied under field conditions against lucern weevil, *Hypera variabilies* (HBST.) **Considering the efficacy among the insecticides tested, application of monocrotophos, endosulfan and malathion were found most effective as compared to other insecticides for controlling the grubs of lucern weevil. Fenvalerate and methamidophos were next in the order of toxicity.**

(*Key words*: **insecticide efficacy, lucern weevil,** *Hypera variabilis*)

INTRODUCTION

The lucern weevil, *Hypera variabilis* (HBST.) causes severe damage to the lucern crop in many parts of India as well as in other countries. The severe damage by this pest in South east plateau of Rajasthan were reported by SRIVASTAVA (1959) for the first time. The grubs are the main culprit because they feed on apical buds and laminae of the top leaves by scraping the epidermis, with the habit of feeding and resting in a curved position. The attacked plants become stunted and skeletonised. There seems to be a very little work done on chemical control of this pest in India, though much work has been reported by several workers abroad. So far, few insecticides have been tested and a vast majority of insecticides of recent origin are yet to be tried. Keeping this in view, the present investigation was undertaken to evaluate the efficacy of some newer insecticides against this pest.

MATERIAL AND METHODS

A field experiment on the efficacy of some insecticides in lucern, against the final instar grubs of lucern weevil, (*Hypera variabilis*) was laid out at Durgapura, Jaipur in randomized block design with three replications. The size of each plot was taken as 3.0 × 2.5m. The insecticides tested were dimethoate, endosulfan, fenvalerate, formothion, leptophos, malathion, methamidophos, methyldemeton, monocrotophos, phosalone, phosphamidon and phoxim in emulsifiable concentrate form and each were applied at 0.05 per cent concentration. Initial trials revealed that lower dose is ineffective for killing adults and final instar grubs. The spraying was done with the help of bucket sprayer 800 litres of fluid solution per hectare, which was found necessary on account of the density of the drop and the type of sprayer employed.

The observations on the population counts of grubs were recorded 24 hours before treatment and 24 hours, 3 days and 7 days after spraying in each plot to observe the quick knock down, intermediary and residual effect of the insecticides. The counts of the grubs was done on 20 randomly selected plants in each plot and pooled together. The per cent control obtained by the insecticides was ascertained with the help of HENDERSON & TILTON (1955) formula:

$$\text{Per cent control} = 100\left(1 - \frac{Ta \times Cb}{Tb \times Ca}\right) \text{ Where}$$

Tb: number of grubs recorded before treatment; Ta: number of grubs recorded after treatment; Cb: number of grubs recorded from the check plot; before treatment; Ca: number of grubs recorded from the check plot after treatment.

The percentage mortality obtained was transformed to angular values and analysed statistically (Table 1.)

RESULTS AND DISCUSSION

The data presented in Table 1, indicate that all the insecticidal treatments resulted in reducing the pest population significantly as against no mortality in control, when observations at any one period were statistically compared.

Among the insecticides tested, the most effective insecticides were monocrotopho

TABLE 1. Relative efficacy of some insecticides against lucern weevil, *Hypera variabilis* (HBST.).

Insecticides	Per cent control after		
	24 hr	3 days	7 days
Dimethoate	50.40 (45.23)	38.10 (38.09)	26.83 (31.16)
Endosulfan	97.13 (80.52)	100.00 (88.19)	68.83 (56.05)
Fenvalerate	89.33 (71.04)	68.73 (56.02)	42.26 (42.85)
Formothion	64.60 (53.51)	58.43 (47.78)	37.00 (34.12)
Leptophos	63.36 (52.77)	46.10 (42.76)	33.10 (35.17)
Malathion	91.56 (73.13)	82.70 (65.46)	55.33 (48.07)
Methamidophos	90.20 (71.80)	81.33 (64.69)	62.56 (52.28)
Methyldemeton	52.26 (46.30)	42.90 (40.91)	32.10 (34.51)
Monocrotophos	100.00 (88.19)	100.00 (88.19)	73.13 (58.78)
Phosalone	72.76 (58.57)	72.90 (58.64)	47.70 (43.66)
Phosphamidon	82.90 (65.51)	72.70 (58.52)	53.00 (46.72)
Phoxim	92.76 (74.51)	78.40 (62.41)	41.46 (40.08)
Control	..	..	..
S Em±	1.14	1.83	1.58
C D at 5%	2.34	3.74	3.25

Figures in parentheses represent angular transformed values.

and endosulfan which gave the maximum pest mortality at all the time intervals and these insecticides were at par and were significantly superior to rest of the insecticides. However, malathion was the next effective insecticide but it did not differ significantly with methamidophos and phoxim which gave good initial and residual kill of the test insect. These findings are similar to those reported by RAM & GUPTA (1975), PRADHAN *et al.* (1960) and KRISHEN KUMAR & RATTAN LAL (1966). The remaining insecticides in their order of efficacy were fenvalerate, phosphamidon, phosalone, formothion, leptophos, methyldemeton and dimethoate which gave less kill of the test insect throughout the observation period.

It can thus be concluded that monocrotophos, endosulfan and malathion can be applied for the control of lucern weevil under field conditions and if possible, green fodder should be washed with water prior to livestock feeding. Though residues of these insecticides on lucern crop need to be studied.

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NOTES ON *IDIOSCOPUS* SPECIES (HOMOPTERA : CICADELLIDAE) DESCRIBED BY DR. H. S. PRUTHI, WITH DESCRIPTION OF A NEW SPECIES FROM MEGHALAYA, INDIA

C. A. VIRAKTAMATH
Department of Entomology, University of Agricultural Sciences, Bangalore, India 560 024

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Idioscopus bimaculatus **(Pruthi) and** ***Idioscopus confuscous*** **(Pruthi) are redescribed and illustrated with additional locality data. A new species,** ***Idioscopus irenae*****, from Meghalaya, is described and illustrated.**

(*Key words*: *Idioscopus bimaculatus* **(Pruthi)**, *Idioscopus confuscous* **(Pruthi)**, *Idioscopus irenae*)

Pruthi (1936) described *Idiocerus bimaculatus* and *I. confuscous* from the Kumaon Hills Uttar Pradesh. Maldonado-Capriles (1965) transferred these two species to *Idioscopus* Baker and indicated that Pruthi (1936) had interchanged the descriptions and illustrations of these two species and provided illustrations of some parts of male genitalia. Datta (1972) also provided illustrations of male genitalia of these species. However, there was disagreement in the illustrations of male genitalia drawn by Maldonado-Capriles (1965) and Datta (1972), especially with respect o the pygoferal processes and anal collar process. I had an opportunity of examining the holotypes of these two species at the Zoological Survey of India (ZSI), Calcutta and found them undissected. The diagrams by Pruthi, Datta and Maldonado-Capriles were based on paratypes. Recently, I collected these two species at Simla on which the present illustrations are based.

1 Idioscopus bimaculatus (Pruthi) (Figs. 1–6)

Idiocerus bimaculatus Pruthi, 1936, *Mem. Indian Mus.* 11: 102; Datta, 1972, *Zool. Anz.*, Leipzig, 189: 430.

Idioscopus bimaculatus: Maldonado-Capriles, 1965, *Proc. ent. Soc. Wash.*, 67: 244.

Bright green in life with white stripe along claval commissure. A spot at each basal angle of scutellum black. Eyes black. Tip of labium and tarsal claws black.

Slender species. Head, pronotum and scutellum shagreened. Head broadly rounded, vertex more or less of uniform length. Pronotum 2.3 times as wide as long with slightly concave hindmargin. Scutellum longer than pronotum, with two oblique, median, impressed lines. Venation obscure basally and as in Fig.6. Eighth sternum of male with an angulate median process.

Male genitalia :

Pygofer widened dorsally, with a strong ventral process. Dorsal apodemes well developed. Anal collar process as in Fig. 1. Plates as long as pygofer. Style with serrated ventral margin (Fig.2). Connective with median anterior process. Dorsal apodeme of aedeagus well developed, shaft compressed with an apical spear-shaped extension at the point where it curves caudally. A pair of processes arise below the opening of gonopore and are curved at an acute angle

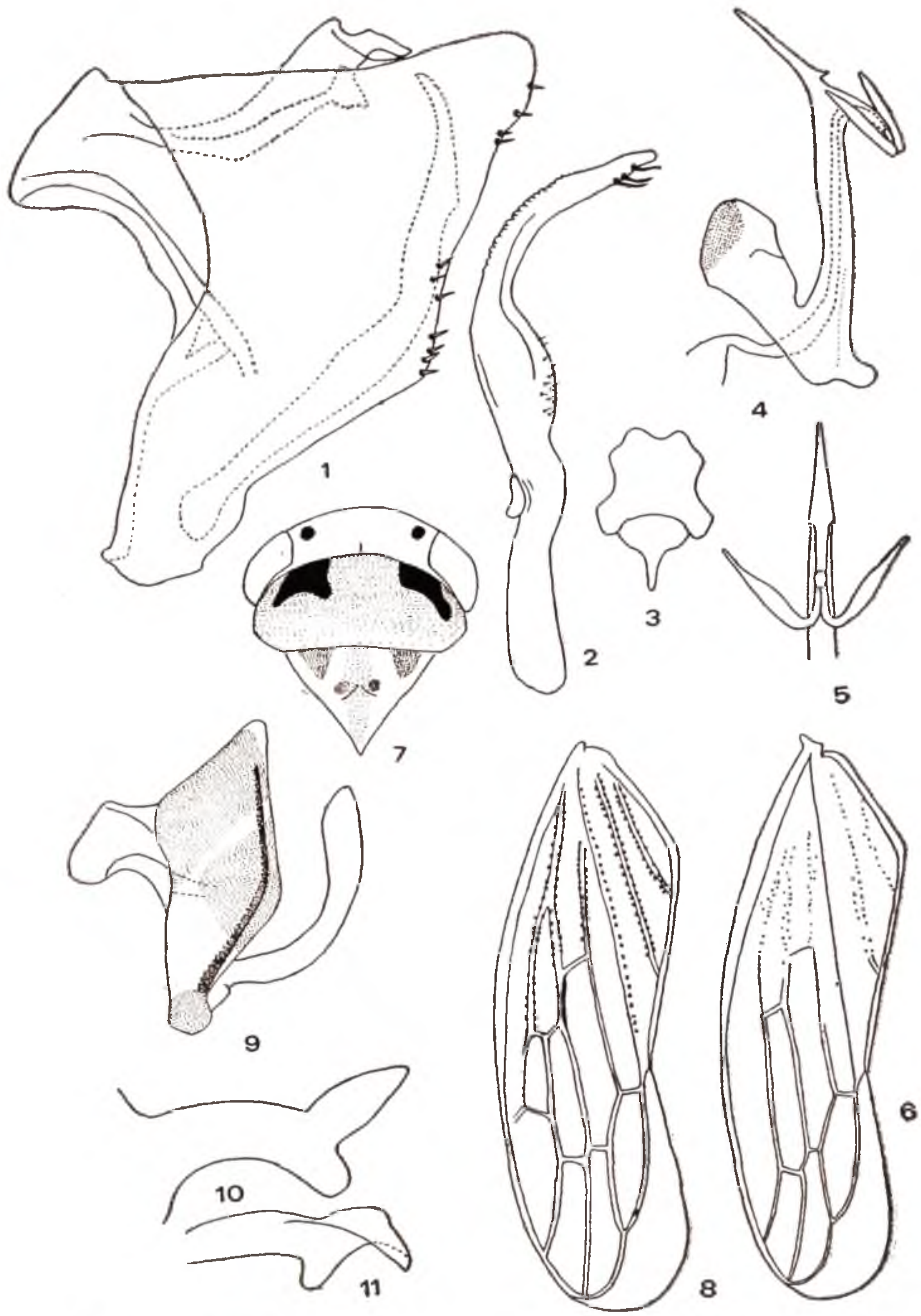

Fig. 1–11. *Idioscopus bimaculatus* (Pruthi). 1, Pygofer; 2. Style; 3. Connective; 4. Aedeagus, lateral view; 5. Aedeagal shaft, caudal view; 6. Forewing. *Idioscopus confusus* (Pruthi)— 7, Head and thorax; 8. Forewing, 9. Pygofer; 10,11, Anal collar process.

dorsolaterally at about one third of their length.

Material examined

Holotype ♂ (not dissected) Kausani (ca 6000 ft.), Almora dist., Kumaon Hills, U.P., 30.v–2.v.30, H.S. Pruthi (Z.S.I. No. 5382/H7) 1♂, 1♀ INDIA : HIMACHAL PRADESH: Simla, 14.x.1979, C.A. Viraktamath, Coll. No.218, ex *Quercus* sp.

Remarks

This species can be distinguished from all other species of *Idioscopus* by its characteristically acutely curved aedeagal processes, pygoferal and anal collar processes and by the distinct coloration.

2. **Idioscopus confuscous**(Pruthi) (Figs. 7–16).

Idiocerus confuscous Pruthi, 1936, Indian Mus., 11: 104.

Idiocerus confuscus: Datta, 1972, *Zool. Anz.*, Leipzig, 189: 432. (misspelling).

Idioscopus confuscous: Maldonado- Capriles, 1965, *Proc. ent. Soc. Wash.*, 67; 245.

Vertex and upper part of face dorsad of ocelli lemon-yellow with two black round spots. Eyes black. Face very pale ochraceous. Male antennal disc black. Pronotum dark brown with two anterior irregular patches black, hindmargin paler. Scutellum ochraceous, two basal triangles and two round spots in middle dark brown, median stripe brownish. Forewings brownish hyaline with dark brown veins, apex of inner claval vein white, major part of Cu bordering subapical cell and the cross-vein between Cu and claval suture whitish-hyaline. Propleuron, dorsal parts of meso- and metapleura lemon-yellow, the latter two ventrally black. Legs lemon-yellow, with dark brown claws, apices of hindtibiae and tarsi dark brown.

Head, pronotum and scutellum shagreened. Clypellus wider at apex. Vertex more or less of uniform length, with a short median sulcus at base. Pronotum 2.26 times as wide as long. Scutellum longer than pronotum. Forewing venation as in Fig. 8, claval veins and basal parts of other veins lined with two rows of prominent pits. Hindmargin of eighth sternum of male with an angulate median process.

Male genitalia :

Pygofer rhomboidal in shape, darkly pigmented except in middle with an elongate slender ventral process and prominent dorsal anterior apodemes. Anal collar process well developed and as in Figs. 10 and 11. Male plate shorter than pygofer. Connective robust, T-shaped with an anterior median projection. Style with serrated vental margin and a row of long setae near apex. Aedeagus with a well developed dorsal apodeme, shaft compressed, sinuate along anterior margin, with round lateral denticles near apex, and possessing two pairs of subequal, ventrally directed, simple, long processes arising below the elongate gonopore.

Material examined

Holotype ♂ (not dissected) Kausani (ca 6000 ft.), Almora dist., Kumaon Hills, U.P., 30. v–2. vi.1930, H.S. Pruthi, (Z.S.I. No. 5385/H7); 1 ♂ INDIA: HIMACHAL PRADESH: Simla, 14.x.1979, C.A. Viraktamath, Coll. No.218 ex *Quercus* sp.

Remarks

This species is very closely related to *Idioscopus shillongensis* Viraktamath (1976) from which it differs in having immaculate fronto-clypeus, differently shaped anal collar process, presence of ventral pygoferal process, differently shaped apex of aedeagal shaft and subequal aedeagal processes. The illustration of 'valve' (correctly-male eighth sternum)

Figs. 12–23. *I. confuscous* (Pruthi). 12, Male eighth sternum; 13, Style; 14, Connective; 15, Aedeagus and connective; 16, Aedeagal processes. *Idiosopus irenae* sp. nov. 17, Forewing; 18, Pygofer, 19, Pygoferal process; 20, Anal collar process; 21, Style; 22, Aedeagus and connective; 23, Aedeagal shaft, caudal view.

given by Maldonado-Capriles (1965) appears to be erroneous.

3. **Idioscopus irenae** sp. nov. (Figs. 17–23).

Beautifully coloured species. Vertex, Pronotum and scutellum bright lemon-yellow. Clavus yellowish-green inner margin of claval suture white, a broad stripe along this, orange, but against the background of fuscous hindwings, visible as copper brown; costal margin greenish-yellow, rest of the wing brownish hyaline. Face, thoracic and abdominal sterna and legs pale-yellow. Eyes black.

Vertex and upper part of face dorsad of ocelli transversely rugulose. Clypellus slightly wider near apex, otherwise more or less rectangular. A seta on gena behind each eye quite prominent. Labium reaching posterior margin of midcoxae. Pronotum shagreened, 2.23 times as wide as long with slightly concave hindmargin. Scutellum longer than pronotum and with two oblique median sulci. Forewing venation as in Fig. 17, claval veins not discernible.

Male genitalia

Pygofer widened dorsally with a ventral pygoferal process which is fold-like for the most part and apically spine-like and with prominent anterior dorsal apodemes. Anal collar process wide at base and caudally narrowed as in Fig.20. Male plates slightly longer than pygofer. Style robust, apically pointed and with serrated ventral margin. Connective robust and T-shaped with a median anterior lobe. Dorsal apodeme well developed, shaft basally curved and then almost straight and compressed, narrowed near apex with two lateral, ventrally directed, processes as in Fig. 23. Gonopore apical on caudal margin.

Male measures 4.9 mm. long and 1.6 mm. wide across eyes.

Type

Holotype ♂, INDIA: MEGHALAYA: Mawsmai Cave, 20. iv. 1978, Coll. I. Dworakowska, deposited in the Department of Entomology, University of Agricultural Sciences, Bangalore

Remarks

This species appears closer to *I. preciosus* Viraktamath (1979), but differs in its characteristic coloration and structure of male genitalia.

This species is named in honour of its collector, Dr. Irena Dworakowska, Warszawa, Poland, for her contribution to Cicadellid taxonomy.

Acknowledgements:—I am grateful to the Director, Zoological Survey of India, Calcutta, for enabling me to study the holotype of Pruthi under his care; to Dr. I. Dworakowska, Warszawa, Poland for her kind gift of leafhoppers. This study was partially financed by the Department of Science and Technology, Government of India.

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METAMORPHIC CHANGES IN THE STRUCTURE OF MIDGUT IN *ROPALIDIA MARGINATA* L. (HYMENOPTERA-VESPIDAE)

H. K. CHATURVEDI & J. P. N. PATHAK
Zoology Department, Madhav Science College, Vikram University, Ujjain, India

(*Received 20 January 1980*)

The larval midgut epithelium starts degeneration during early prepupal stage. The process of the degeneration of larval epithelium is immediately followed by the regeneration process. In the prepupa of 48 hr the larval epithelium is rejected in *toto* and the regenerative cells present in the larval midgut increase in number and size to replace the larval epithelium. Thus the pupal midgut epithelium differentiates from the regenerative cells and is retained as functional adult midgut epithelium.

(*Key words:* **metamorphic changes, midgut structure,** *Ropalidia marginata*)

INTRODUCTION

The published literature regarding the metamorphosis of the midgut may be categorised into two categories (i) The midgut epithelium regenerates from the regenerative cells of the larva (KOWALEVSKY, 1887; VANEY, 1902; DEEGENER, 1904; PEREZ, 1910; BUSHNELL, 1936; RISLER, 1961; KATHURIA, 1971). (ii) The adult midgut epithelium differentiates from the posterior end of the foregut i.e, the posterior part of the anterior imaginal ring (POYARKOFF, 1910; MURRY & TIEGS, 1935; PATAY 1939). In the present paper the metamorphosis of the midgut in *Ropalidia marginata* is studied and discussed in the light of existing views.

MATERIALS AND METHODS

The nests of *Ropalidia marginata* were collected from the Verandah of houses and other shelter places. The insects were reared in the lab. The last instar larvae stop feeding and close their chamber by papery secretion. The prepupal period prolong nearly for two days. The pupal period lasts for about 8 to 9 days. For histological studies larvae, prepupae, pupae and emerging adults were dissected in .65% saline solution. The alimentary canal was fixed in aqueous Bouin's for 24-hours and by usual methods sections were cut 6 to 10 micra thick and stained by iron haematoxylin with eosin as counter stain.

RESULTS

Larval midgut: The larval midgut, the longest part of the alimentary canal, looks like a closed sac. It measures about 6 mm in length. In well fed larvae the epithelial cells are columnar with distinct large oval nuclei and granulated cytoplasm (Fig. 1). Cells are lined by straited border and may vary in shape with their secretory activity. Nidi are present, each nidus is a very small structure and consists of 3 to 4 less densely staining regenerative cells.

Prepupal changes: The metamorphosis of the midgut epithelium begins by the end of last larval stage. Cells stop their secretory activity, therefore very few secretory vesicles were observed. In the prepupa of 24 hr, the undigested food encloses in a sac of peritrophic membrane and moves downward with the development of an opening between the midgut and hindgut. As soon as the faecal matter is pushed in the hindgut the passage is again plugged by the degenerating cells. The faecal matter is thrown out of the body before pupation. The epithelial cells start degeneration with downward movement of the faecal matter, therefore, the anterior midgut epithelium degenerates first.

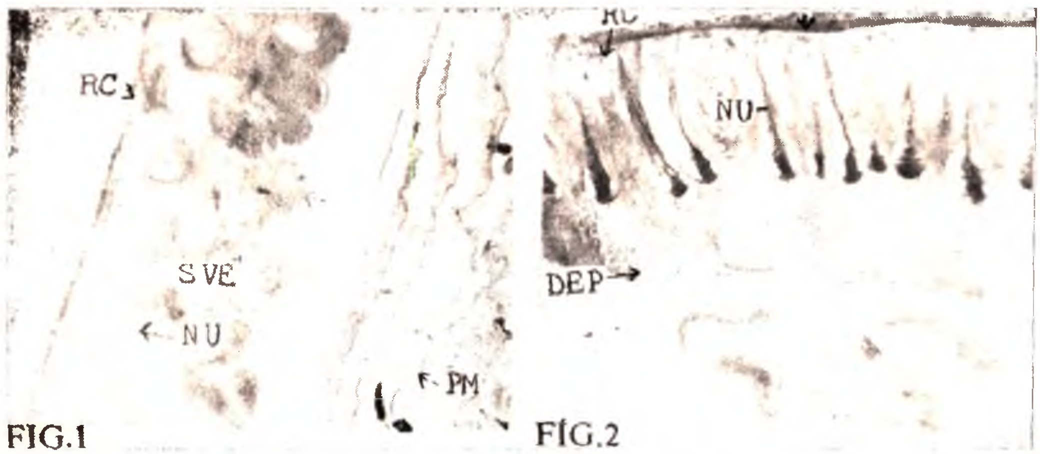

Fig. 1—Photomicrograph of T.S. of midgut of larva (×200). Fig. 2—Photomicrograph of T.S. of midgut of 24 hr (prepupa (×200).

ABBREVIATIONS FOR FIGURES 1-7

CM—Circular muscles; DEP—Degenerating epithelium; EP—Epithelium; LM—Longitudinal muscles; MU—Musculature; PM—Peritrophic membrane; RC—Regenerative cells; SVE—Secretory vesicles; YB—Yellow body.

During degeneration, epithelial cells elongate enormously, to loose their shape (Fig. 2). The tips of epithelial cells become highly vacuolated and are discharged in the lumen. Nuclei are also elongate to loose their specific shape. The regenerative cells increase considerably in number and size to differentiate into a new epithelium.

Pupal changes: In first 24 hours of the pupal stage a newly undifferentiated pupal epithelium develops from the larval regenerative cells which replace the larval epithelium completely. The mass of degenerated larval epithelium is pushed in the lumen as "yellow body." The new epithelial cells appear as undifferentiated mass of cells with large nuclei, though their boundaries are not clear (Fig. 3). In the next 24 hr the midgut epithelium undergoes a degree of reorganisation. The cell boundaries become clear and cells show an elongation in their structure. Few regenerative cells are also observed in between them (Fig. 4). Thus within 48 hours a definite pupal epithelium develops, which shows weak secretory activity. The secretory activity increases with the age of the pupa. In the pupa of 72 hour the midgut shows certain folds morphologically, therefore, the midgut epithelium also shows certain infoldings (Fig. 5).

In the pupa of 80 to 96 hour the secretory activity is at its peak and the secretory vesicles pinched off from the tips of epithelial cells to accumulate in the lumen. The secretory vesicles and the "yellow body" mixes with each other and homogenous fluid appears in the lumen of the midgut. This fluid increases in the quantity and gradually forces the midgut to expand into a bag like structure. Therefore, the infoldings disappear in the midugt of the 144 hour pupa (Fig. 6). This mechemical distention, formation of new epithelial cells and

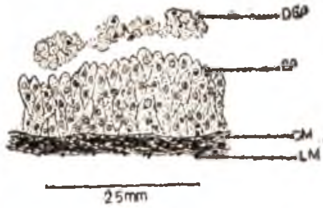

FIG.3

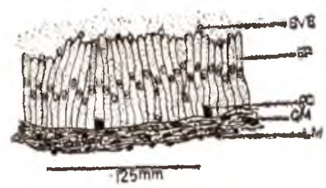

FIG.4

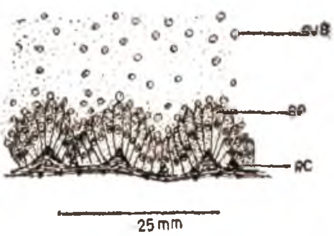

FIG.5

FIG.6

Fig. 3 – Diagram of the midgut of 24 hr pupa. Fig. 4 – Diagram of the midgut of 48 hr pupa. Fig. 5 – Diagram of the midgut of 72 hr pupa. Fig. 6 – Diagram of the midgut of 144 hr pupa.

streching of the walls increases the size of the midgut in the puapa of 160–172 hours.

In the pupa of 192 hours a passage again develops between midgut and hindgut. Through this opening the degenerated fluid and contents of the secretory vesicles of the midgut move in the hindgut. This movement releases the pressure of the midgut, therefore the midgut epithelium again shows some infoldings. At this time the cells of midgut epithelium show granulated cytotoplasm with large oval nuclei. The same epithelium continues as adult epithelium which emerges at the age of 200 to 215 hours. The midgut epithelium of emerging adult shows the tall columnar cells with distinct cell boundaries. A straited border is also seen. However, in due course of time some vesicles again makes its appearance as a result of secretory activity (Fig. 7).

DISCUSSION

The larval midgut epithelium is usually replaced during metamorphosis by the pupal epithelium, which develops from the regenerative cells present with the larval epithelium. The pupal epithelium is also replaced at the pupal-adult moult by the adult epithelium (Deegener, 1904; Bushnell, 1936; Lotmar, 1945; Dobrovsky, 1951; Glockner, 1958; Risler, 1961; Kathura, 1971). In *Ptychoptera albimana* (Ameen, 1969) a pupal epithelium was not observed in the midgut and after degeneration of the larval epithelium, the adult epithelium develops mainly from regenerative cells and only partly from the cells migrating from the anterior imaginal ring. In *Nasonia* (Hymenoptera) the pupal epithelium develops from the larval regenerative cells, whose anterior half degenerates and posterior half differentiate into adult epithelium (Tiegs, 1922).

In *Ropalidia marginata* the regenerative

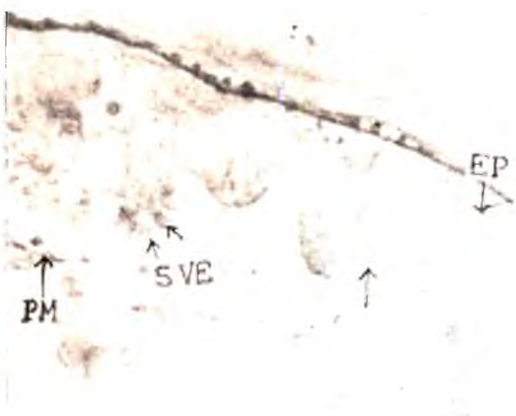

FIG.7

Fig. 7 —Photomicrograph of midgut of emerging adult (×200).

cells replace the midgut epithelium of larva in *toto* during larval-pupal moult. The degenerated mass is pushed in the lumen as "yellow body." The pupal epithelium of *Ropalidia marginata* is functional and shows the merocrine secretion. This functional pupal epithelium is retained as the adult epithelium. Therefore, in *Ropalidia marginata* there is only one replacement, the functional pupal epithelium is retained in the adult without any modification.

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TWO SPECIES OF PSEUDOSCORPIONS FROM SOUTH INDIA (PSEUDOSCORPIONIDA, HETEROSPHYRONIDA)

S. SIVARAMAN
Department of Zoology, Loyola College, Madras 34, India

(*Received 9 February 1980*)

Two new species are described: *Comsaditha camponota* **sp. nov. and** *Lechytia madrasica* **sp. nov., both from Madras, Tamil Nadu. The relationships with closely allied species are discussed.**

(*Key words:* **Pseudoscorpionida, Heterosphyronida, new species from South India)**

The species of the genera *Comsaditha* and *Lechytia* are very poorly known from India. The two species included in this study are collected from soil litter by using Berlese funnel (Hoff, 1966) with a modification for arresting the alcohol vapour from reaching the soil sample above (Sivaraman, 1979). Type specimens are deposited in the Museum of Department of Zoology, Loyola College, Madras.

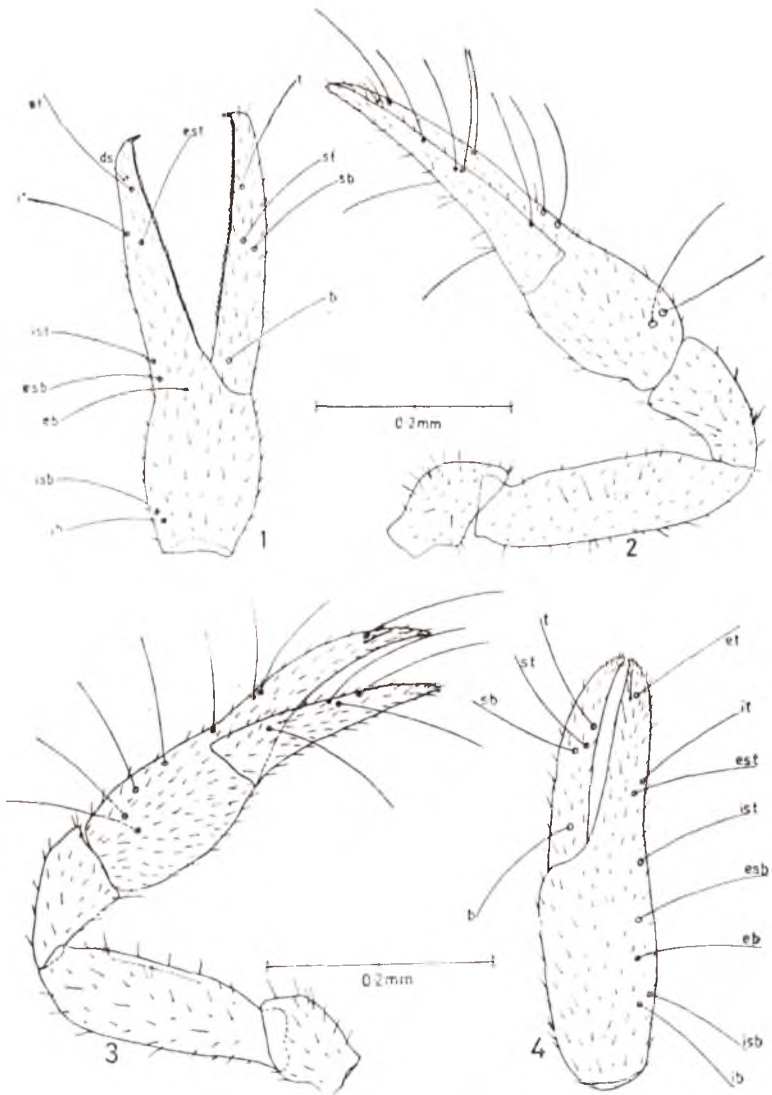
1. Comsaditha camponota sp nov. (Figs 1 & 2)

Carapace slightly broader than long, sub-quadrate with a distinct medially depressed, triangular and laterally denticulate epistomal process; pale brown with reticulate sculpture in the lateral marginal regions; with eyes, of which the anterior pair well developed and more than thrice their diameter caudad of the anterior margin; posterior pair bigger than anterior pair in diameter and separated from the anterior pair by four times of their diameter. Setae robust and acuminate; chaetotaxy, 54 vestitural setae, of which 12 on the anterior margin and 6 on the posterior margin. Carapace, 0.92 times as long as wide.

Tergites and sternites ill-sclerotised, uniseriate, with about 8 marginal setae each. Sternites smooth, weakly divided, with 10 to 12 slenderly acuminate setae; XI tergite and sternite with two pseudotactile setae each; guard sclerites with 2 setae. Coxal spines numbering 6 on each coxa and acuminate; monosetose intercoxal tubercle present; female and male genital area of typical facies.

Chelicerae of usual form, robust, reddish brown; palm of the chelicera with large number of fine granulations and with four accessory setae. Of the four tactile setae *is* being long and strong; *ls* absent. Fixed finger with terminal tooth well developed followed by 6 to 7 blunt teeth, of which the proximal one being stout; lamina interior ill developed. Movable finger basally thick and curved terminally; terminal tooth well developed, followed by 5 well spaced rounded teeth, the last three being much smaller in size. Serrula exterior of 13 blades of which the distal 5 fuse together basally and free from the finger margin. Galea absent; galeal seta much distad of the median region of the finger, shorter than the fixed finger in length. Flagellum of 9 pinnate blades. Chelicera, 1.76 times as long as deep, 2.32 times as long as the movable finger.

Palps robust, reddish brown, much longer than the length of the body; investing setae numerous; trochanter with a short pedicel; extensor margin evenly rounded; 1.72 to 1.86 times as long as wide; femur with a



C. camponota sp. nov. (1) chela lateral view. (2) pedipalp entire (♀).
L. madrasica sp. nov. (3) pedipalp entire (♂). (4) chela lateral view.

short stout pedicel, with a slight concavity in the extensor margin and a convexity in the flexor margin; 3.5 to 3.75 times as long as wide; tibia subtriangular, 1.62 to 1.72 times as long as wide; chela more swollen in the median region, 3.8 to 3.95 times as long as wide; 1.53 to 1.64 times as long as femur, 2.7 to 3.0 times as long as tibia; hand moderately stout, inconspicuously granulate medially, 1.3 to 1.4 times as long as wide; fingers unequal in length, movable finger slightly longer, 1.8 to 1.9 time as long as hand, 0.64 to 0.65 times as long as the total length of the chela. Movable finger with 40 and fixed finger with 48 teeth, which are minute and narrow. Tactile

setae of the fingers typical for the genus. *St* and *sb* slightly caudad of median, almost transversely contiguous and closer to *b* than the distance between *t* and the finger tip; *et* subterminal and about one areolar diameter caudad of *ds* (pseudotactile setae); *est* slightly posterior to *it* and distad of median: *ist*, *esb* and *eb* in an oblique basal series; *esb* distinctly closer to *ist* than to *eb*.

Legs of usual facies; yellowish with distal segments bearing numerous investing setae. Femora of legs I and II movably articulated and that of III and IV immovably articulated.

Leg I: Basifemur longer than telofemur; basifemur, 3.2 times; telofemur, 2.75 times; tibia, 3.3 times; trasus, 5.3 times as long as deep. Leg IV: Miofemur very thick and granulated; metatarsus shorter than telotarsus; metatarsus with pseudotactile seta which is equal to the l ngth of it, and telotarsus with a pseudotactile seta which is shorter than it. Claws normal and arolium shorter than claws. Miofemur, 2.7 times; tibia, 3.5 times; metatarsus, 2.6 times teoltarsus, 6.4 times as long as deep.

Measurements of Holotype female in mm.

Total body length, 0.956; maximum width of the abdomen, 0.434; carapace, 0.389 by 0.423; chelicera, 0.245 by 0.139; movable finger, 0.106 long.

Palps: Trochanter, 0.172 by 0.100; femur, 0.344 by 0.089; tibia, 0.189 by 0.111; chela, 0.512 by 0.133; hand, 0.178 by 0.133; fingers, 0.344 long.

Leg I: basifemur, 0.178 by 0.056; telofemur, 0.122 by 0.044; tibia, 0.111 by 0.033; tarsus, 0.178 by 0.033; Leg IV : miofemur, 0.300 by 0.111; tibia, 0.234 by 0.066; metatarsus, 0.111 by 0.039; telotarsus, 0.178 by 0.028.

Measurements of Allotype male in mm.

Total body length, 0.934; maximum width, 0.423.

Holotype : ♀, INDIA : TAMIL NADU, Madras from decaying leaves, 15.ix.1978, S. Sivaraman.

Allotype : ♂, 15.ix.1978. Collection data same as for the holotype.

Types are deposited in the museum of Department of Zoology, Loyola College, Madras.

Distribution : India.

Comsaditha camponota n.sp. is very closely related to *C. indica* Murthy and *C.pygmaea* Chamberlin in having 50 to 54 vestitural setae on the carapace. It could be distinguished from *C. pygmaea* by the slender nature of the palpal femur and chela (femur 3.5 to 3.75 times; chela 3.8 to 3.95) and separated from *C.indica* based on the slender nature of palpal femur and stouter nature of chela. It could also be distinguished in having flagellum of 9 pinnate blades instead of 7 as in *C.indica*.

2. **Lechytia madrasica** sp nov. (Figs. 3&4)

Carapace, chelicerae and palps light brown; abdomen and legs olive brown, epistome of the carapace absent; anterior margin of the carapace not protruded in the middle region (epistomal emargination but finely dentate; eyes or eye spots absent; carapace narrowed posteriorly, with the maximum width in the region of the ocular row of setae. Dorsum of the carapace smooth and the lateral regions slightly reticulate. Surface of the carapace with 18 well developed, strong setae arranged in the formula 6–4–4–2–2; 1.15 to 1.20 times as long as wide.

Tergites fairly sclerotised and smooth, with 6 setae in each; the lateral setae of the tergites I to IV relatively small; tergite XI with 2 long psuedotactile setae; each of the sternite with 8 setae, of which the median 4 long and the lateral 4 short.

Male genitalia with 10 to 12 widely spaced setae on the anterior operculum, on each side of the lateral half of the posterior operculum 3 setae border the genital slit and one placed apart; a row of eleven setae bordering each lateral margin of the genital slit; genitalia of female simple, 4 to 6 setae in a group at the anterior end of the sclerotic band and 6 to 8 setae lateral to each arm of the band.

Chelicerae robust, shorter than carapace; palm with fine granulations and rasp-like; surface of the palm not with an accessory seta caudad of *es*; *sb* and *b* more or less at the same level; *is* as long as movable finger; flagellum with 8 simple long and acuminate blades arranged in a linear row; of which 6th and 7th are overlapped with 5th and 8th respectively. Serrula exterior with 12 to 14 blades, all of them basally united; terminal tooth of the fixed finger well developed followed by one big triangular and four small teeth; movable finger with terminal tooth well developed followed by 3 top 4 small subsequal teeth; spinneret well developed in females and absent in the males; galeal seta in the distal half of the finger and extending 2/3 length of the finger; serrula interior well developed and terminally divided into 3 to 4 finger like projections; chelicerae, 1.9 to 2.0 times as long as deep and 2.1 to 2.2 times as long as movable finger.

Palps shorter than the body, segments smooth, with slender and acuminate investing setae; trochanter pedicellate with a medium sized tubercle, 1.7 to 1.8 times as long as wide; femur without a distinct pedicel, smaller than the carapace and chela, slender and distally more swollen, 3.05 to 3.1 times as long as wide; tibia with a short pedicel, more or less triangular, smaller than the hand, 1.45 to 1.5 times as long as wide; chela slender, without a distinct pedicel, 4.2 to 4.3 times as long as wide; hand more or less oval in outline, with 4 tactile setae on the dorsal aspect, 1.85 to 1.9 times as long as wide; fingers longer than the hand; subequal and more or less straight; fingers with simple lamallae and the distal part finely toothed; fixed finger distally with 6 or 7 small teeth and the movable finger distally with 3 or 4 small teeth, venom teeth well developed. Distribution of the tactile setae characteristic of the genus. Dorsum of the hand with 4 setae; *ib* and *isb* basal in position; *esb* distal to *eb; ist* at the base of the finger; *est* and *it* with 2 areolar diameters between them; *et* in the distal half of the finger, proximal to *ds; st* and *sb* of the movable finger very close to each other about the diameter of areolium and near to *t* than to *b*.

Manducatory process of the maxilla with 4 long an strong setae; mesoapical process of pedal coxa I well developed; inter coxal tubercle absent; coxa of walking legs with 6 setae each, situated as a group in the middle region.

Legs smooth; segments very slender an pale yellowish; Leg I: Basifemur longer than telofemur; basifemur, 3.5 times; telofemur, 2.0 times; tibia, 3.0 times and miotarsus, 7.2 times as long as deep.

Femora of leg IV robust; metatarsi of legs III and IV with a long seta in the middle of the segment. Leg IV: Miofemur, 1.7 times; tibia, 3.4 times; metatarsus, 3.3 times and telotarsus, 7.2 times as long as deep. Claws well developed and sickle-like; arolia entire, shorter than claws.

Measurements of Holotype male in mm.

Total body length, 1.068; maximum width 0.389; carapace, 0.345, by 0.30; chelicerae, 0.211 by 0.111; movable finger, 0.10 long.

Palps : trochanter, 0.133 by 0.07; femur, 0.256 by 0.08; tibia, 0.145 by 0.10; chela, 0.423 by 0.10; hand, 0.189 by 0.10, fingers, 0.234 long.

Leg I : basifemur, 0.156 by 0.044; telofemur, 0.078 by 0.039; tibia, 0.10 by 0.033 and miotarsus, 0.20 by 0.028.

Leg IV : miofemur, 0.245 by 0.145; tibia, 0.189 by 0.056; metatarsus, 0.111 by 0.033 and telotarsus, 0.20 by 0.028.

Measurements of Allotype female in mm.

Total body length, 0.968; maximum width, 0.372.

Holotype : ♂ INDIA: TAMIL NADU: Nungambakkam, Madras, from soil litter, 8.vii. 1977, S. Sivaraman.

Allotype ; ♂ collection data same as for the holotype. Deposited in the Museum of Department of Zoology, Loyola College, Madras.

Materials examined : 4 ♂♂ and 3 ♀♀.
Distribution : India.

This new species resembles *L. sakagamii* Morikawa from Japan and *L. inidica* Murthy in having the tactile setae *sb* and *st* of the movable palpal finger not touching each other, but is distinguished from both in respect of its body size; *L. madrasica* could also be separated from *L. indica* based on the slender nature of the palpal podomeres and from *L. sakagamii* based on the distinctly constricted nature of the carapace in the posterior region, by the absence of the eyes and based on the palpal femoral ratio (*L. madrasica* 3.05 to 3.1. times as long as broad whereas in *L. sakagamii* 3.25 times as long as broad.)

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BRIEF COMMUNICATION

NEW RECORDS OF PARASITES AND PREDATORS OF IMPORTANT INSECT PESTS OF MANGO

P. L. TANDON & R. P. SRIVASTAVA
Central Mango Research Station (IIHR), Lucknow, India 226 006

(*Received 3 January 1980*)

During survey studies of natural parasites and predators of major pests of mango (*Idioscopus clypeolis, Drosicha mangiferae, Chlumetia transversa, Aspidiotus destructor* and *Rastrococcus iceryoides*) in Uttar Pradesh, sixteen species of parasites namely *Aneristus ceroplastae, Bracon greeni, Brachymeria lasus, Comperiella bifasciata, Chartocerus* sp., *Chrysonotomia* sp., *Dinocarsis* sp., *Goryphus* sp., *Hormius* sp., *Metastenus concinnus, Meteorus* sp., *Metaphycus* sp., *hederaceous, Microterys flavus, Pediobius bruchicida, Tetrastichus* sp., and *Thomsonisca desantisiellus*, and three species of predators namely *Scymnus coccivora, Sumnius cardoni* and *Cybocephalus* sp. were recorded for the first time from India on the respective hosts.

(*Key words* : **parasites, predators, major pests of mango**)

RAWAT & JAKHMOLA (1970), TANDON & LAL (1976, 1978, 1979) and SRIVASTAVA *et al.* (1979) reported a few species of hymenopterous parasites; coccinellids, mites and spiders as predators on mango pests like *Drosicha mangiferae, Idioscopus clypealis, Rastrococcus iceryoides, Aspidiotus destructor* and *Chlumetia transversa*. With a view to study the complete parasitic and predatory fauna of major pests of mango, survey studies were conducted in Lucknow, Unnao, Raibareilly, Sitapur, Farrukhabad, Hardoi, Bulandshahar, Nainital and Rampur distiets of U P.

During survey *Aspidiotus destructor*, a serious coccid pest of mango, was found parasitised by *Aneristus ceroplastae* Girault, *Comperiella bifasciata* Howard (Encyrtidae), *Chartocerus* sp. (Signiphoridae), *Chrysonotomia* sp. (Eulophidae), and *Thomsonisca desantisiellus* Shaffee (Aphelinidae). Among all these parasities, *Thomsonisca desantisiellus* was the most common. *Pulvinaria polygonata*, another scale which is common on mango in U P. was found parasitised by *Metaphycus* sp. *hederaceous* (Encyrtidae) while *Rastrococcus iceryoides* (Pseudococcid) was parasitised by *Dinocarsis* sp., *Microterys flavus* (Howard) (Encyrtidae), *Metastenus concinnus* Walker (Pteromelidae) and *Tetrastichus* sp. (Eulophidae). Apart from these parsites, two beetles namely *Cybocephalus* sp. (Nitidulidae) and *Scymnus coccivora* (Coccinelliade) were also observed predating on nymphs of *R. iceryoides*. Mango shoot borer, *Chlumetia transversa* which is one of the most serious pests of mango was noticed parasitized by *Bracon greeni* Ashmead, *Meteorus* sp. (Braconidae) and *Goryphus* sp. (Ichneumonidae). *Orthaga euadrusalis* commonly known as mango leaf webber which became a serious pest recently in U.P. was found parasitized by *Brachymeria lasus* Howard (Chalcididae), *Hormius* sp. (Braconidae), *Pediobius bruchicida* and *Tetrastichus* sp. (Eulophidae). *Sumnius cardoni*, a coccinellid was found predating on nymphs of mango mealy bug, *Drosicha magiferae*.

Contribution No. 874 of Indian Institute of Horticultural Research, 255, Upper Palace Orchards, Bangaore-560006.

Although *Aneristus ceroplastae* was reported parasitising on *Pulvinaria psidii* (Bernnett and Hughes, 1959), *Brachymeria lasus* on *Nephantis serinopa* (Joy *et al*., 1973), *Bracon greeni* on *Eublema amabilis* and *Apion corchori* (Negi *et al*., 1945 and Tripathi & Ram, 1971), *Compariella bifasciata* Howard on *Aonidiella orientalis* (Agrawal 1969), *Goryphaus* sp. on *Hiacides postica* (Mehra and Shah, 1970), *Hormius* sp. on *Macella* sp. (Vadivelu *et al*., 1975) and *Scymnus coccivora* predating on *Pulvinaria psidii* (Narayanan *et al*., 1964) but there is no previous record of these 19 species of natural enemies on their respect-tive hosts mentioned in this article, hence form new records.

Acknowledgements:—The authors are grateful to Dr. K.L. Chadha, Project Coordinator (Fruits) and Head, Central Mango Research Station, Lucknow and Dr. G.S. Randhawa, Director, Indian Institute of Horticultural Research, Bangalore for their keen interest in the studies and facilities provided. Thanks are also due to Dr. N.C. Pant, Director, Commonwealth Institute, for getting the bioagents identified and to Shri N.K. Sharma, Technician for his help in the field work.

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REPORTS AND NEW RECORDS

A NEW ROOT-INFESTING MEALY BUG OF COCONUT

M. R. G. K. Nair, A. Visalakshi & George Koshy
College of Agriculture, Vellayani 695 522, Kerala State, India

A new species of the mealy bug *Rhizoecus** (Homoptera : Pseudococcidae) was found infesting roots of coconut in the sandy tracts of Trivandrum District in 1977. Species of *Rhizoecus* recorded as root feeding plant pests are *R. theae* Kaw. & Takon on tea, *R. hibisci* Kaw. ornamentals and shoe flower plant and *R. kondonis* Kaw. on citrus all in Japan (Kawai & Takagi, 1971) and *R. americanus* (Hamb.) on nursery plants of areca palm, pigmy date palm, soft leaf yucca, Norfolk Island pine and bamboo palm in Florida, monocrotophos gives best control of the pest (Poe, 1972). This is the first time a species of this mealy bug is recorded as infesting the roots of coconut palm. The full grown mealy bug (Fig.3) is cream coloured, sub-globular, measuring 2.4 mm in length and 1.9 mm in breadth; the surface is smooth and segmentation is very faint; legs are atrophied considerably. Each insect is enclosed within a loose jacket of pure white cottony felt. Groups of the mealy bug are seen on the thin fibrous roots especially at the junctions with side roots. Eggs are laid in continuous chains which may emerge out of the felt covering through an opening which is present near the genital pore. The egg chain subsequently breaks distributing the eggs among the sand particles around the roots. Eggs are also deposited within the felt covering of the mealy bug and the mealy bug shrinks after laying of the eggs. A female lays 67—82 eggs. The egg is white, smooth and oval in shape measuring 0.48 mm in legnth 0.24 mm in width (Fig. 1). The crawler is white measuring 0.48 mm in length and 0.21 mm in width (Fig. 2).

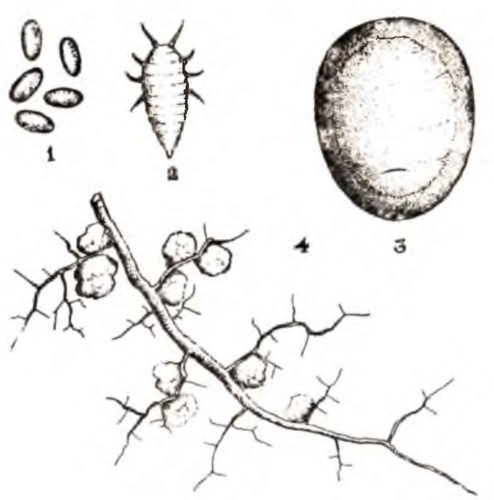

Fig. 1—4. Life stages of *Rhizoecus* sp., Fig. 1. Eggs., Fig. 2. Crawler., Fig. 3. Adult female; Fig. 4. Root showing felt growth of *Rhizoecus* sp.

The region of the root where the mealy bugs are present clustered becomes discoloured turning brown in colour; the side roots in such cases are invariably dried up. In severe cases of infestation an average of 8.5 colonies are noted per 10 cm length of the root and the young plants which are infested thus show yellowing and loss of vigour.

*D. J. Williams of Commonwealth Institute of Entomology, London, has identified it as a new species and he proposes to describe it when he takes up revision of Indian Rhizoecini. Thanks are expressed to the Director of the Institute and to Dr. Williams for the identification.

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SYCOPHILA sp. (EURYTOMIDAE : HYMENOPTERA) – A NEW PEST OF *JASMINUM GRANDIFLORUM* LINN.

S. EASWARAMOORTHY*
R. SIVAGAMI VADIVELU &
T. S. MUTHUKRISHNAN
Division of Entomology, Tamil Nadu Agricultural Uuiversity, Coimbatore, India 641 003

Jasmine has been reported to be attacked by a number of insect pests (Kanakaraj David, 1958; 1960; Radha *et al.*, 1967; Sivagami & Janarthanan, 1963; Sivagami & Nagappan, 1967; Radhakrishna Nair & Nair, 1974). Recently, the Jathimalli (*Jasminum grandiflorum* Linn.) bushes grown in the Tamil Nadu Agricultural University Campus were observed to be affected by a new shoot borer, *Sycophila* sp.

The adult wasp laid tiny whitish eggs inside the bark of tender shoot. The grub bored into the tender shoot and fed on the inner contents, hollowing out the stem. Pupation took place inside the shoot. The infested shoots lost their colour and turgour. The leaves of such twigs and twigs themselves became darkened and dried up in a week or two after infestation depending upon the intensity of damage. The infestation which was mainly on tender and fresh shoot was concentrated to the top one third of the bushes. Under heavily infested condition a stem of 10 cm length contained 1 to 9 bore holes. The incidence was observed in June—July and it lingered upto September – October The peak incidence was found to coincide with the new flush of shoot growth.

All the six varieties of *J. grandiflorum* viz. white, Bangalore, Ciombatore, Lucknow, Thimmapuram and Triploid were found infested by the hymenopteran shoot borer while the other jasmines remained free. Among the varieties Thimmapuram was most susceptible with 77 per cent shoot damage. Lucknow and Coimbatore recorded 37.5 and 36.0 per cent incidence and were on par while other varieties exhibited lesser degree of damage. The intensity of damage was also high in Thimmapuram, in which the number of bore holes per 10 cm length of shoot ranged from 1 to 9 with a mean of 4 and number of grubs and pupae from 20 to 49 per shoot.

The pest *Sycophila* sp. was found parasitized by an eulophid *Chrysonotomyia? cinctiventris* (Ashmead). Another hymenopteran, *Megastigmus* sp. (Torymidae) was also found in association with the pest, but its role as a parasite of the pest is to be confirmed.

Spraying the Jathimalli bushes with Nuvacron (1.5 ml/litre) gave relief from this pest.

Thanks are due to the Director, British Museum, London for ideniifying the insects.

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Erratum

In *Entomon* Vol. 5, No. 2, June 1980 page 152, please read ***T.*** *horntinus* as ***T.*** *hornotinus* under remarks and on page 154 in key at attribute 13, setae on trochanters I–IV : 1–2–1 as 1–1–2–1 for *T. ludhianaensis* sp. nov. and setae on trochanters I–IV: 1–2–2 as 1–1–2–2 for ***T.*** *pruni* Maninder and Ghai.

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